Endangered Species Act - Reinitiated Section 7 Consultation

# BIOLOGICAL OPINION

Effects of Pacific Coast Ocean and
Puget Sound Salmon Fisheries
During the 2000-2001 Annual Regulatory Cycle

Agency: National Marine Fisheries Service,
Sustainable Fisheries Divisions;
Bureau of Indian Affairs;
U.S. Fish and Wildlife Service

Consultation Conducted by
National Marine Fisheries Service
Protected Resources Division

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## INTRODUCTION

The National Marine Fisheries Service (NMFS) is required under section 7 of the Endangered Species Act (ESA) to conduct consultations which consider the impacts of salmon fisheries to species listed under the ESA. This biological opinion considers the effects of Pacific coast ocean salmon fisheries and salmon fisheries in Puget Sound on listed salmon, and steelhead not already covered by existing opinions. This will be the first year that NMFS has combined its consultation on Pacific coast salmon fisheries with those that occur in Puget Sound. NMFS has combined these consultations for reasons of efficiency, because of the interrelated nature of the preseason planning processes, and to provide a more inclusive assessment of harvest-related impacts to the listed species.

The ocean salmon fisheries in the exclusive economic zone (EEZ) off Washington, Oregon, and California are managed under authority of the Magnuson-Stevens Act. Annual management recommendations are developed according the "Pacific Coast Salmon Plan" (FMP) of the Pacific Fishery Management Council (PFMC). The PFMC provides its management recommendations to the Secretary of Commerce, who implements the measures in the EEZ if they are found to be consistent with the Magnuson-Stevens Act and other applicable law. Because the Secretary, acting through NMFS, has the ultimate authority for the FMP and its implementation, NMFS is both the action agency and the consulting agency with respect to PFMC fisheries.

Puget Sound fisheries are managed by the State of Washington and the Puget Sound treaty tribes pursuant to the Puget Sound Salmon Management Plan (PSSMP) which was adopted by court order as a sub-proceding related to *U.S.* v. *Washington*. The purpose of the PSSMP is to establish guidelines for management of salmon and steelhead resources originating in Puget Sound. The PSSMP applies to all marine and freshwater fisheries in Puget Sound from the Strait of Juan de Fuca eastward. NMFS, the U.S. Fish and Wildlife Service (FWS), and Bureau of Indian Affairs (BIA) all have substantive roles and authorities related to the management of Puget Sound fisheries and it is these federal actions that provide the basis for NMFS' consultation.

## CONSULTATION HISTORY

NMFS has considered the effects on salmon species listed under the ESA resulting from PFMC fisheries in several previous biological opinions (Table 1). In a biological opinion dated March 8, 1996, NMFS considered the impacts to salmon species then listed under the ESA resulting from implementation of the FMP including spring/summer chinook, fall chinook, and sockeye salmon from the Snake River and Sacramento River winter chinook. Provisions of the March 8, 1996, opinion regarding Sacramento River winter chinook were revised in a reinitiated section 7 biological opinion dated February 18, 1997. Three subsequent biological opinions dated April 30, 1997, April 29, 1998, and April 30, 1999 considered the effects of PFMC fisheries on the growing catalogue of listed species (Table 1). However, these latter opinions were specific to the annual regulations adopted pursuant to implementation of the FMP and therefore were limited in duration to the year in question. In another opinion dated April 28, 1999 NMFS considered the effect of implementing Amendment 13 to the salmon FMP on the three listed coho ESUs. This last opinion was programmatic in that it considered the amendment itself rather than just the annual regulations. It therefore provides long-term coverage for PFMC fisheries regarding the three listed coho ESUs. The most recent opinion related to PFMC fisheries considered the effect of PFMC fisheries on newly listed Central Valley Spring-Run chinook and California Coastal chinook (NMFS 2000a).

This consultation history provides a mix of long and short-term coverage for the various ESUs with respect to PFMC ocean salmon fisheries. The effects of implementing the FMP on the Snake River fall chinook, Snake River spring/summer chinook, and Snake River sockeye, Sacramento River winter chinook, the three coho ESUs, and Central Valley Spring-Run chinook and California Coastal chinook are covered by biological opinions that are still applicable (see Table 1). The effects of PFMC fisheries on the remaining ESUs have been considered previously, but only in opinions with an annual duration. This biological opinion therefore considers the effects of PFMC fisheries during the 2000 regulatory cycle on those ESUs that are not covered by an existing opinion (see Table 1).

The NMFS considered the effect of the 1999 PFMC fisheries and the recently completed Pacific Salmon Treaty Agreement (NMFS 1999c) on Puget Sound chinook and Hood Canal summer-run chum (which originate in Puget Sound), but this will be the first year that NMFS will consider the effects of Puget Sound salmon fisheries on listed salmonids.

**Table 1. NMFS biological opinions on ocean fisheries implemented under the FMP and duration of the proposed action covered by each opinion.**

| Date of Current Opinion | Opinion Duration | ESU covered |
|---|---|---|
| March 1, 1991 | superseded | Sacramento River winter chinook |
| March 8, 1996 | until reinitiated<br>5 years | Snake River chinook and sockeye<br>Sacramento River winter chinook |
| February 18, 1997 | 4 years | Sacramento River winter chinook |
| April 30, 1997 | 1 year<br>1 year<br>1 year<br>1 year | Southern Oregon/Northern California Coastal coho,<br>Central California Coastal coho,<br>Umpqua River cutthroat trout<br>all steelhead ESUs proposed for listing |
| April 29, 1998 | 1 year<br>1 year<br>1 year<br>1 year | Southern Oregon/Northern California Coastal coho<br>Cental California Coastal coho<br>Umpqua River cutthroat trout<br>seven listed steelhead ESUs |
| April 28, 1999 | until reinitiated | Southern Oregon/Northern California Coastal coho<br>Central California Coastal coho<br>Oregon Coastal Natural coho |
| April 30, 1999 | 1 year<br>1 year<br>1 year<br>1 year<br>1 year<br>1 year<br>1 year<br>1 year<br>1 year | Puget Sound chinook<br>Lower Columbia River chinook<br>Upper Willamette River chinook<br>Upper Columbia River chinook<br>nine steelhead ESUs<br>Ozette Lake sockeye<br>Hood Canal summer chum<br>Lower Columbia River chum<br>Umpqua River cutthroat trout (under USFWS) |
| April, 2000 | until reinitiated | Central Valley Spring-Run chinook<br>California Coastal chinook |

## BIOLOGICAL OPINION

I. Description of the Proposed Action

There are four federal actions being considered in this opinion and all overlap to a great extent in both location and timing. In addition, all the fisheries within the action area fall under the court jurisdiction of U.S. v Washington. U.S. v Washington requires that management objectives be established on a run-by-run, river-by-river basis unless otherwise agreed by the parties. The result has been a management system that bases management decisions on the needs of the weakest stocks. The first proposed action is implementation by NMFS of 2000 annual ocean salmon fishing regulations developed in accordance with the FMP including the recently adopted Amendment 13. (Annual regulations apply to the period from May 1 of the current year through April 31 of the following year.) These regulations govern ocean fisheries off the coasts of Washington, California and Oregon within the EEZ (3-200 miles offshore)(see Review of 1999 Ocean Salmon Fisheries (PFMC 2000a) for details on the specific fishery locations and historical catch and effort data). They are generally sport and troll fisheries targeting chinook and coho. The ocean salmon fisheries in the exclusive economic zone (EEZ) off Washington, Oregon, and California are managed under authority of the Magnuson-Stevens Act. Annual management recommendations are developed according the "Pacific Coast Salmon Plan" (FMP) of the Pacific Fishery Management Council (PFMC). The PFMC provides its management recommendations to the Secretary of Commerce, who implements the measures in the EEZ if they are found to be consistent with the Magnuson-Stevens Act and other applicable law. Because the Secretary, acting through NMFS, has the ultimate authority for the FMP and its implementation, NMFS is both the action agency and the consulting agency with respect to PFMC fisheries.

The remaining federal actions provide a web of overlapping and interrelated jurisdiction for Puget Sound fisheries. Puget Sound fisheries are managed by the State of Washington and the Puget Sound treaty tribes pursuant to the Puget Sound Salmon Management Plan (PSSMP) which was adopted by court order as a sub-proceding related to U.S. v. Washington. The purpose of the Plan is to establish guidelines for management of salmon and steelhead resources originating in Puget Sound. The Plan applies to all marine and freshwater fisheries in Puget Sound from the Strait of Juan de Fuca eastward. Fisheries within Puget Sound occur at different times throughout the year depending on the location, the fishing regime and the target species. The gear used varies by fishery but includes troll, hook and line, gill net, beach seine and purse seine gears. Puget Sound fisheries occur on all five salmon species depending on the location.

NMFS has authority for Fraser Panel fisheries in northern Puget Sound and annually decides whether to relinquish control to the bilateral Fraser Panel pursuant to the PST. The Fraser Panel controls sockeye and pink fisheries conducted in the Strait of Juan de Fuca and San Juans region (northern Puget Sound), the Georgia Strait and Fraser River in Canada, and certain high seas and territorial waters westward. The Fraser Panel assumes control from July 1 through mid-September, although the fisheries generally occur between late July and August. The BIA provides funding to the Puget Sound tribes that supports their fisheries management programs conducted under the PSSMP and has tribal trust obligations under U.S. v Washington. The USFWS is party to the Hood Canal Salmon Management Plan (HCSMP) which is a regional plan and stipulated order related to the PSSMP. The state, tribal, and federal parties to the Hood Canal Plan establish management objectives for stocks originating in Hood Canal including listed chinook and summer-run chum stocks. Management under the HCSMP effects those fisheries where Hood Canal salmon stocks are caught.

These four actions have been grouped into this single biological opinion for efficiency and in compliance with the regulatory language of section 7 which allows NMFS to group a number of similar, individual actions within a given geographic area or segment of a comprehensive plan (50 CFR 402.14(b)).

B. Action Area

In developing the management recommendations, the PFMC analyzes several management options for ocean fisheries occurring in the EEZ. The analysis includes assumptions regarding the levels of harvest in state marine, estuarine, and freshwater areas, which are regulated under authority of the states. The States of Washington, Oregon and California generally manage their marine waters consistent with the management scheme approved by the Secretary of Commerce.

NMFS establishes fishery management measures for ocean salmon fisheries occurring in the EEZ (3-200 nautical miles off shore). In the case where a state's actions substantially and adversely affect the carrying out of the FMP, the Secretary may, under the Magnuson-Stevens Act, assume responsibility for the regulation of ocean fishing in state marine waters; however that authority does not extend to a state's internal waters. The PSSMP covers marine and fresh water areas of Puget Sound from the entrance of the Strait of Juan de Fuca inward. For the purposes of this opinion, the action area is the EEZ, which is directly affected by the federal action, the coastal marine waters of the states of Washington, Oregon and California, which may be indirectly affected by the federal action, and the marine and freshwater areas of Puget Sound.

**Table 2. Summary of salmon species listed under the Endangered Species Act. Those shown in bold are the subject of the consultation in this biological opinion.**

| Species | Evolutionarily Significant Unit | Present Status | Federal Register Notice |
|---|---|---|---|
| | | | |
| Chinook Salmon (*O. tshawytscha*) | Sacramento River Winter | Endangered | 54 FR 32085 8/1/89 |
| | Snake River Fall | Threatened | 57 FR 14653 4/22/92 |
| | Snake River Spring/Summer | Threatened | 57 FR 14653 4/22/92 |
| | **Puget Sound** | Threatened | 64 FR 14308 3/24/99 |
| | **Lower Columbia River** | Threatened | 64 FR 14308 3/24/99 |
| | **Upper Willamette River** | Threatened | 64 FR 14308 3/24/99 |
| | **Upper Columbia River Spring** | Endangered | 64 FR 14308 3/24/99 |
| | Central Valley Spring | Threatened | 64 FR 50394 9/16/99 |
| | California Coastal | Threatened | 64 FR 50394 9/16/99 |
| Chum Salmon (*O. keta*) | **Hood Canal Summer-Run** | Threatened | 64 FR 14570 3/25/99 |
| | **Columbia River** | Threatened | 64 FR 14570 3/25/99 |
| Coho Salmon (*O. kisutch*) | Central California Coastal | Threatened | 61 FR 56138 10/31/96 |
| | S. Oregon/ N. California Coastal | Threatened | 62 FR 24588 5/6/97 |
| | Oregon Coastal | Threatened | 63 FR 42587 8/10/98 |
| Sockeye Salmon (*O. nerka*) | Snake River | Endangered | 56 FR 58619 11/20/91 |
| | **Ozette Lake** | Threatened | 64 FR 14528 3/25/99 |
| Steelhead (*O. mykiss*) | **Southern California** | Endangered | 62 FR 43937 8/18/97 |
| | **South-Central California** | Threatened | 62 FR 43937 8/18/97 |
| | **Central California Coast** | Threatened | 62 FR 43937 8/18/97 |
| | **Northern California** | Threatened | 65 FR 6960 2/11/00 |
| | **Upper Columbia River** | Endangered | 62 FR 43937 8/18/97 |
| | **Snake River Basin** | Threatened | 62 FR 43937 8/18/97 |
| | **Lower Columbia River** | Threatened | 63 FR 13347 3/19/98 |
| | **California Central Valley** | Threatened | 63 FR 13347 3/19/98 |
| | **Upper Willamette River** | Threatened | 64 FR 14517 3/25/99 |
| | **Middle Columbia River** | Threatened | 64 FR 14517 3/25/99 |

## II. Status of the Species and Critical Habitat

NMFS has determined that the action being considered in this biological opinion may affect the following species and critical habitat provided protection under the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq*.; ESA): nine listed steelhead ESUs, Columbia River (CR) chum and Hood Canal summer-run (HCS) chum salmon, and any of four recently listed chinook salmon ESUs including Puget Sound (PS) chinook , Lower Columbia River (LCR) chinook, Upper Willamette River (UWR) chinook (see Table 2).

Based on the best scientific and commercial expected take from the PFMC ocean salmon fisheries and Puget Sound fisheries of listed Ozette Lake sockeye salmon and Upper Columbia River Spring chinook salmon is at most an occasional event. NMFS believes it would be impossible to measure or detect potential effects of the proposed action on these species (which, according to the Interagency Section 7 Handbook, is considered an "insignificant effect") and concludes that the proposed action is not likely to adversely affect these species. Consequently, these species will not be considered further in this opinion.

Critical habitat has now been designated for all of the affected ESUs. Offshore marine areas that are under the jurisdiction of the PFMC are not included as part of the designated critical habitat. However, marine and freshwater areas in Puget Sound are included. Most of the harvest-related activities occur from boats or along river banks. Gear that is used include hook-and-line gear and commercial purse seines and gillnets that do not substantively affect the habitat. Based on the best scientific and commercial data available, NMFS has concluded that the proposed actions are not likely to adversely affect this critical habitat; therefore, critical habitat will not be considered further in this opinion.

### A. Species and Critical Habitat Description

#### 1. Hood Canal Summer Chum

The HCS chum ESU includes summer-run chum salmon populations in Hood Canal in Puget Sound and in Discovery and Sequim Bays on the Strait of Juan de Fuca. It may also include summer-run fish in the Dungeness River, but the existence of that run is uncertain. Five hatchery populations are considered part of the ESU including those from the Quilcene National Fish Hatchery, Long Live the Kings Enhancement Project (Lilliwaup Creek), Hamma Hamma River Supplementation Project, Big Beef Creek reintroduction Project, and the Salmon Creek supplementation project in Discovery Bay. Although included as part of the ESU, none of the hatchery populations were listed.

#### 2. Upper Willamette River chinook

The UWR chinook ESU occupies the Willamette River and tributaries upstream of Willamette

Falls. Historically, access above Willamette Falls was restricted to the spring when flows were high. In autumn low flows prevented fish from ascending past the falls. The Upper Willamette spring chinook are one of the most genetically distinct chinook groups in the Columbia River Basin. Fall chinook salmon spawn in the Upper Willamette but are not considered part of the ESU because they are not native. None of the hatchery populations in the Willamette River are listed although the spring-run hatchery stocks were included in the ESU.

3. Lower Columbia River chinook

The LCR ESU includes all native populations from the mouth of the Columbia River to the crest of the Cascade Range, excluding populations above Willamette Falls. Celilo Falls, which corresponds to the edge of the drier Columbia Basin Ecosystem and historically may have presented a migrational barrier to chinook salmon at certain times of the year, is the eastern boundary for this ESU. Not included in this ESU are "stream-type" spring-run chinook salmon found in the Klickitat River (which are considered part of the Mid-Columbia River Spring-Run ESU) or the introduced Carson spring-chinook salmon strain. "Tule" fall chinook salmon in the Wind and Little White Salmon Rivers are included in this ESU, but not introduced "upriver bright" fall-chinook salmon populations in the Wind, White Salmon, and Klickitat Rivers. For this ESU, the Cowlitz, Kalama, Lewis, White Salmon, and Klickitat Rivers are the major river systems on the Washington side, and the Willamette and Sandy Rivers are foremost on the Oregon side. The majority of this ESU is represented by fall-run fish and includes both north migrating tule-type stocks and far-north migrating bright stocks. There is discussion among some co-managers as to whether any natural-origin spring chinook salmon persist in this ESU. Fourteen hatchery stocks were included in the ESU; one was considered essential for recovery (Cowlitz River spring chinook) but was not listed.

4. Puget Sound chinook

The PS chinook ESU includes all runs of chinook salmon in the Puget Sound region from the North Fork Nooksack River to the Elwha River on the Olympic Peninsula. Chinook salmon in this area all exhibit an ocean-type life history although there are several populations with an adult spring run timing and ocean distribution. Although some spring-run chinook salmon populations in the PS ESU have a high proportion of yearling smolt emigrants, the proportion varies substantially from year to year and appears to be environmentally mediated rather than genetically determined. Spring-run chinook hatchery populations from Kendall Creek, the North Fork Stillaguamish River, White River, and Dungeness River, and fall run fish from the Elwha River are listed.

B. Life History

General life history information is presented below for chinook salmon and chum salmon. More specific information regarding species status and recent population trends are provided in the following section for the ESUs that are the focus of this opinion.

1. Chum Salmon

Historically, chum salmon were distributed throughout the coastal regions of western Canada and the United States, as far south as Monterey Bay, California. Presently, major spawning populations are found only as far south as Tillamook Bay on the northern Oregon coast.

Chum salmon (*Oncorhynchus keta*) are semelparous, spawn primarily in freshwater and, apparently, exhibit obligatory anadromy (there are no recorded landlocked or naturalized freshwater populations) (Randall et al. 1987). Chum salmon spend more of their life history in marine waters than other Pacific salmonids. Chum salmon, like pink salmon, usually spawn in the lower reaches of rivers, with redds usually dug in the mainstem or in side channels of rivers from just above tidal influence to nearly 100 km from the sea. Juveniles outmigrate to seawater almost immediately after emerging from the gravel that covers their redds (Salo 1991). This ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus *Oncorhynchus* (e.g., coastal cutthroat trout, steelhead, coho salmon, and most types of chinook and sockeye salmon), which usually migrate to sea at a larger size, after months or years of freshwater rearing. This means that survival and growth in juvenile chum salmon depend less on freshwater conditions (unlike stream-type salmonids which depend heavily on freshwater habitats) than on favorable estuarine conditions. Another behavioral difference between chum salmon and species that rear extensively in freshwater is that chum salmon form schools, presumably to reduce predation (Pitcher 1986), especially if their movements are synchronized to swamp predators (Miller and Brannon 1982).

2. Chinook Salmon

Chinook salmon is the largest of the Pacific salmon. The species' distribution historically ranged from the Ventura River in California to Point Hope, Alaska in North America, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey 1991). Additionally, chinook salmon have been reported in the Mackenzie River area of northern Canada (McPhail and Lindsey 1970). Of the Pacific salmon, chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for chinook salmon, 7 total ages with 3 possible freshwater ages. This level of complexity is roughly comparable to sockeye salmon (*O. nerka*), although sockeye salmon have a more extended freshwater residence period and utilize different freshwater habitats (Miller and Brannon 1982, Burgner 1991). Two generalized freshwater life-history types were initially described by Gilbert (1912): "stream-type" chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" chinook salmon migrate to the ocean within their first year. Healey (1983, 1991) has promoted the use of broader definitions for "ocean-type" and "stream-type" to describe two distinct races of chinook salmon. This racial approach incorporates life history traits, geographic distribution, and genetic differentiation and provides a valuable frame of reference for comparisons of chinook salmon populations. For the purposes of this Opinion, those chinook salmon (spring and summer runs) that spawn upriver from the

Cascade crest are generally "stream-type"; those which spawn downriver of the Cascade Crest (including in the Willamette River) are generally "ocean-type."

The generalized life history of Pacific salmon involves incubation, hatching, and emergence in freshwater, migration to the ocean, and subsequent initiation of maturation and return to freshwater for completion of maturation and spawning. Juvenile rearing in freshwater can be minimal or extended. Additionally, some male chinook salmon mature in freshwater, thereby foregoing emigration to the ocean. The timing and duration of each of these stages is related to genetic and environmental determinants and their interactions to varying degrees. Salmon exhibit a high degree of variability in life-history traits; however, there is considerable debate as to what degree this variability is the result of local adaptation or the general plasticity of the salmonid genome (Ricker 1972, Healey 1991, Taylor 1991). More detailed descriptions of the key features of chinook salmon life history can be found in Myers, et al. (1998) and Healey (1991).

C. Population Dynamics and Distribution

This section provides more specific information about the ESUs that are the focus this opinion. Included here is information regarding the distribution and population structure of the ESUs, and size, variability, and trends of the components (stocks or populations) of the ESUs.

1. Chum Salmon

*Hood Canal Summer-run Chum*

The HCS chum ESU encompasses those streams with summer chum from the Dungeness River in the eastern Strait of Juan de Fuca throughout Hood Canal in Puget Sound. This group of chum populations is distinguishable from other Puget Sound chum by an early return and spawning timing that creates a temporal separation from fall chum stocks spawning in the same rivers. This allows reproductive isolation between summer and fall stocks (WDF *et al.* 1993).

Hood Canal summer-run chum use the estuarine and marine areas in Hood Canal and the Strait of Juan de Fuca for rearing and seaward migration as juveniles. The fish spend two to five years in the northeast Pacific Ocean feeding areas prior to migrating southward during the summer months as maturing adults along the coasts of Alaska and British Columbia in returning to their natal streams (PNPT/WDFW 2000). Little is known about the details of the ocean migration and distribution of salmon from the HCS chum ESU. Some data suggests that Puget Sound chum, including those in the HCS chum ESU, may not make an extended migration into northern British Columbian and Alaskan waters, but instead may travel directly offshore into the north Pacific Ocean (Hartt and Dell 1986). In general, maturing chum salmon in the North Pacific begin to enter coastal waters from June to November. Stock composition data from Canadian fisheries in the Strait of Juan de Fuca indicate significant Hood Canal summer chum presence in August, trailing off rapidly in early September (data from G. Graves, NWIFC).

Summer chum mature primarily at three and four years of age, with low numbers returning at ages two and five. Adults delay migration in extreme terminal marine areas for up to several weeks before entering the streams to spawn. Hood Canal summer chum enter freshwater from early August through mid-October and spawn from late August through mid-October (WDF *et al.* 1993). Spawning occurs in the lower one to two miles of each summer chum stream. This characteristic may reflect an adaptation to low flows present during their late summer/early fall spawning ground migration timing, which confines spawning to areas with sufficient water volume. However, this spawning pattern also makes the incubating eggs more vulnerable to scour during periods of high flows (PNPT/WDFW 2000).

The causes of decline for the HCS chum ESU have been attributed to a combination of high fishery exploitation rates, shifts in climatic conditions that have changed patterns and intensity of precipitation, and the cumulative effects of habitat degradation, especially for those systems in the Strait of Juan de Fuca region of the ESU (PNPT/WDFW 2000; Johnson *et al.* 1998). Total fishery exploitation rates on the HCS chum ESU averaged 44.5% from 1974-1994 (range = 12.2%-81.2%). Total exploitation rates dropped dramatically in 1995, averaging 3.8% (range = 2.7-5.1%) since that time (Table 9), as a result of fishery actions taken to protect summer chum and other salmonid species.

Of the sixteen populations of summer chum identified in this ESU, seven are considered to be "functionally extinct" (Skokomish, Finch Cr., Anderson Cr., Dewatto, Tahuya, Big Beef Cr., and Chimicum). The remaining nine populations are well distributed throughout the ESU except for the eastern side of Hood Canal; however, those populations were among the least productive in the ESU (PNPT/WDFW 2000).

This ESU has two geographically distinct regions: the Strait of Juan de Fuca (SJF) and Hood Canal (HC). Although the populations all share similar life history traits, the summer chum populations in the two regions are affected by different environmental and harvest impacts and display varying survival patterns and stock status trends.

In the Hood Canal region, summer chum are still found in the Dosewallips, Duckabush, Hamma Hamma, Lilliwaup, Big and Little Quilcene, and Union Rivers. A few chum have been observed in other systems during the summer chum migration period, but these observations are sporadic and are thought to be strays from other areas. Although abundance was high in the late 1970's, abundance for most Hood Canal summer chum populations declined rapidly beginning in 1979, and has remained at depressed levels (Table 3). The terminal run size for the Hood Canal summer chum stocks averaged 28,971 during the 1974-1978 period, declining to an average of 4,132 during 1979-1993. Abundance during the 1995-1998 period improved, averaging 10,844. However, much of the increase in abundance can be attributed to a supplementation program for the Big/Little Quilcene River summer chum stock begun in 1992. Escapements in the Union have been stable or increasing relative to historical levels. Escapements to the Dosewallip and Duckabush rivers have been generally above threshold levels of concern, but are highly variable. Escapements in the Hamma Hamma and particularly the Lilliwaup have been below threshold escapement levels often in recent years (Table 3).

Supplementation programs were instituted in 1992 for the Big/Little Quilcene, the Hamma Hamma and Lilliwaup stocks due to the assessment of high risk of extinction for these stocks (PNPT/WDFW 2000). The Quilcene program has been quite successful at increasing the number of returning adults. The Hamma Hamma and Lilliwaup programs have been hampered by an inability to collect sufficient broodstock. A re-introduction program was also started in Big Beef Creek using the Quilcene stock. It is too early to assess the success of that program. Other re-introduction programs may be initiated in the future, but will depend on the development of additional broodstock sources so as not to become dependent on Quilcene as the sole donor stock.

A habitat assessment, conducted as part of the Summer Chum Salmon Conservation Initiative for Hood Canal and Strait of Juan de Fuca summer chum stocks (PNPTC/WDFW 2000), concluded that channel, riparian forest and sub-estuarine conditions were moderately to severely degraded in all the watersheds due to a history of logging, road building, rural development, agriculture, water withdrawal, and channel manipulations throughout the ESU.

In the Strait of Juan de Fuca, summer chum stocks are found in Snow, Salmon, and Jimmycomelately Creeks and the Dungeness River. (The Snow and Salmon are treated as a single stock complex.) The terminal abundance of summer chum in the Strait of Juan de Fuca region began to decline in 1989, a decade after the decline observed for summer chum in Hood Canal. Terminal abundance declined from an average of 1,923 for the 1974-1988 period to a average of 477 during 1989-1994 period. During the most recent period (1995-1998) the average for the region has increased to 1,039. However, much of the increase may be due to the supplementation program in the Snow/Salmon system that was initiated in 1992. Escapements in Jimmycomelately have continued to be poor, i.e., less than 100 spawners in the last three years. There are no systematic surveys for summer chum in the Dungeness. However, their presence is routinely noted in surveys for other species. The status of the summer chum population in the Dungeness is therefore unknown.

An assessment of the habitat in the Strait of Juan de Fuca chum watersheds concluded that these were among the most degraded watersheds in the ESU (PNPT/WDFW 2000). Improvement in habitat conditions will be essential for successful recovery of summer chum in this region of the ESU.

**Table 3. Hood Canal summer chum terminal abundance by stock and year** (Lampsakis 2000). Stocks considered to be extinct are in italics.

| Return Year | HC Summer Chum ESU | Hood Canal Region | | | | | | | | | | | Strait of Juan de Fuca Region | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Skokomish* | *Tahuya* | Union | B.Quilcene/ L. Quilcene | *Big Beef* | *Anderson* | Dosewallips | Duckabush | Hamma Hamma | Lilliwaup | *Dewatto* | Snow/ Salmon | Jimmy comelately |
| 1974 | 14,430 | 357 | 882 | 68 | 841 | 75 | 0 | 3,600 | 3,588 | 2,453 | 617 | 181 | 1,330 | 438 |
| 1975 | 29,194 | 2,601 | 3,352 | 203 | 3,061 | 1,333 | 226 | 2,604 | 2,598 | 8,495 | 1,643 | 1,427 | 1,300 | 353 |
| 1976 | 66,803 | 4,865 | 18,661 | 583 | 9,861 | 1,368 | 250 | 3,492 | 6,507 | 8,165 | 7,918 | 3,640 | 1,129 | 365 |
| 1977 | 16,790 | 921 | 2,129 | 220 | 1,742 | 325 | 28 | 3,461 | 2,641 | 1,803 | 1,221 | 654 | 1,239 | 405 |
| 1978 | 27,158 | 261 | 548 | 132 | 5,279 | 749 | 18 | 2,093 | 2,090 | 9,045 | 2,743 | 1,121 | 2,293 | 787 |
| 1979 | 8,798 | 100 | 377 | 313 | 620 | 200 | 6 | 1,246 | 1,247 | 3,244 | 526 | 158 | 591 | 170 |
| 1980 | 17,036 | 78 | 904 | 1,051 | 1,770 | 310 | 5 | 3,061 | 2,082 | 828 | 1,248 | 591 | 3,783 | 1,326 |
| 1981 | 5,416 | 219 | 286 | 84 | 589 | 147 | 2 | 103 | 909 | 1,512 | 598 | 84 | 681 | 203 |
| 1982 | 9,198 | 253 | 267 | 476 | 1,161 | 0 | 0 | 1,006 | 1,369 | 1,589 | 261 | 65 | 2,152 | 599 |
| 1983 | 4,411 | 45 | 188 | 372 | 2,157 | 0 | 0 | 84 | 105 | 249 | 39 | 33 | 885 | 254 |
| 1984 | 4,686 | 91 | 196 | 268 | 1,372 | 27 | 1 | 260 | 366 | 208 | 258 | 61 | 1,212 | 367 |
| 1985 | 2,715 | 111 | 214 | 585 | 577 | 0 | 0 | 380 | 48 | 372 | 161 | 33 | 171 | 61 |
| 1986 | 8,078 | 50 | 243 | 4,225 | 1,325 | 0 | 0 | 124 | 385 | 377 | 217 | 45 | 795 | 292 |
| 1987 | 5,607 | 56 | 145 | 795 | 2,483 | 9 | 0 | 13 | 18 | 38 | 51 | 8 | 1,527 | 464 |
| 1988 | 8,758 | 30 | 153 | 664 | 2,265 | 0 | 0 | 679 | 511 | 452 | 290 | 24 | 2,638 | 1,052 |
| 1989 | 2,565 | 33 | 21 | 1,044 | 778 | 0 | 0 | 34 | 127 | 34 | 100 | 5 | 215 | 173 |
| 1990 | 1,337 | 67 | 8 | 365 | 390 | 0 | 0 | 9 | 49 | 106 | 3 | 0 | 278 | 63 |
| 1991 | 1,893 | 3 | 5 | 228 | 837 | 0 | 0 | 262 | 107 | 74 | 33 | 34 | 184 | 125 |
| 1992 | 3,651 | 3 | 0 | 140 | 948 | 0 | 0 | 657 | 619 | 123 | 90 | 0 | 454 | 616 |
| 1993 | 1,344 | 2 | 0 | 252 | 163 | 0 | 0 | 105 | 105 | 69 | 72 | 1 | 463 | 110 |
| 1994 | 2,633 | 1 | 0 | 742 | 744 | 0 | 0 | 226 | 264 | 372 | 106 | 0 | 163 | 15 |
| 1995 | 10,332 | 0 | 0 | 723 | 4,589 | 0 | 0 | 2,796 | 828 | 478 | 79 | 0 | 616 | 223 |
| 1996 | 21,735 | 9 | 5 | 496 | 9,597 | 0 | 0 | 7,005 | 2,661 | 777 | 100 | 0 | 1,054 | 30 |
| 1997 | 10,113 | 0 | 0 | 482 | 8,006 | 0 | 0 | 47 | 475 | 104 | 31 | 7 | 901 | 61 |
| 1998 | 5,389 | 57 | 0 | 246 | 3,086 | 0 | 0 | 339 | 228 | 128 | 24 | 12 | 1,171 | 98 |
| 1998 | 4,627 | 0 | 1 | 159 | 3,237 | 0 | 0 | 351 | 92 | 256 | 8 | 2 | 514 | 7 |
| 974-78 Avg. | 30,875 | 1,801 | 5,114 | 241 | 4,157 | 770 | 104 | 3,050 | 3,485 | 5,992 | 2,829 | 1,405 | | |
| 979-94 Avg. | 5,508 | 71 | 188 | 725 | 1,136 | 43 | 1 | 516 | 520 | 603 | 253 | 71 | | |
| 974-88 Avg. | 15,272 | | | | | | | | | | | | 1,448 | 475 |
| 989-94 Avg. | 2,237 | | | | | | | | | | | | 293 | 184 |
| 995-99 Avg. | 10,439 | 13 | 1 | 421 | 5,703 | 0 | 0 | 2,108 | 857 | 349 | 48 | 4 | 851 | 84 |

( Skokomish River includes only catch data. No escapement data are available.)

2. Chinook Salmon

### *Upper Willamette River Chinook*

Upper Willamette River chinook are one of the most genetically distinct groups or chinook in the Columbia River Basin. This may be related in part to the narrow time window available for passage above Willamette Falls. Chinook populations in this ESU have a life history pattern that includes traits from both ocean- and stream-type life histories. Smolt emigrations occur as young of the year and as age-1 fish. Ocean distribution of chinook in this ESU is consistent with an ocean-type life history with the majority of chinook being caught off the coasts of British Columbia and Alaska. Spring chinook from the Willamette River have the earliest return timing of chinook stocks in the Columbia Basin with freshwater entry beginning in February. Historically, spawning occurred between mid-July and late October. However, the current spawn timing of hatchery and wild chinook in September and early October likely is due to hatchery fish introgression.

The abundance of naturally-produced spring chinook in the ESU has declined substantially from historic levels. Historic escapement levels may have been as high as 200,000 fish per year. The production capacity of the system has been reduced substantially by extensive dam construction and habitat degradation. From 1946-50, the geometric mean of Willamette Falls counts for spring chinook was 31,000 fish (Myers *et al*. 1998), which represented primarily naturally-produced fish. The most recent 5 year (1995-1999) geometric mean escapement above the falls was 27,800 fish, comprised predominantly of hatchery-produced fish (Table 4). Nicholas (1995) estimated 3,900 naturally spawning adults[1] in 1994 for the ESU, with approximately 1,300 of these spawners being naturally produced. There has been a gradual increase in naturally spawning fish in recent years, but it is believed that many of these are first generation hatchery fish. The long-term trend for total spring chinook abundance within the ESU has been approximately stable although there was a series of higher returns in the late-80s and early-90s that are associated with years of higher ocean survival. The great majority of fish returning to the Willamette River in recent years have been of hatchery-origin.

Historically, there were five major basins that produced spring chinook including the Clackamas, North and South Santiam Rivers, McKenzie, and the Middle Fork Willamette. However, between 1952-1968 dams were built on all of the major tributaries occupied by spring chinook, blocking over half the most important spawning and rearing habitat. Dam operations have also reduced habitat quality in downstream areas due to thermal and flow effects. Dams on the South Fork Santiam and Middle Fork Willamette eliminated wild spring chinook in those systems (ODFW 1998a). Although there is still some natural spawning in these systems below the dams, habitat quality is such that there is probably little resulting production and the spawners are likely of hatchery origin. Populations in several smaller tributaries that also used to support spring chinook are believed to be extinct (Nicholas 1995).

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[1]Naturally spawning adults include all adults on the spawning grounds without regard to origin. Natural spawners include only those spawners whose parents spawned in the wild.

The available habitat in the North Fork Santiam and McKenzie rivers was reduced to 1/4 and 2/3, respectively, of its original capacity. Spring chinook on the Clackamas were extirpated from the upper watershed after the fish ladder at Faraday Dam washed out in 1917, but recolonized the system after 1939 when the ladder was repaired. NMFS was unable to determine, based on available information whether this represents a historical affinity or a recent, human-mediated expansion into the Clackamas River. Regardless, NMFS included natural-origin spring chinook as part of the listed populations and considers Clackamas spring chinook as a potentially important genetic resource for recovery.

The McKenzie, Clackamas, and North Santiam are therefore the primary basins that continue to support natural production. Of these the McKenzie is considered the most important. Prior to construction of major dams on Willamette tributaries, the McKenzie produced 40% of the spring chinook above Willamette Falls and it may now account for half the production potential in the Basin. Despite dam construction and other habitat degradations, the McKenzie still supports substantial production with most of the better quality habitat locate above Leaburg Dam. The interim escapement objective for the area above the Dam is 3,000-5,000 spawners (ODFW 1998a). Pristine production in that area may have been as high as 10,000, although substantial habitat improvements would be required to again achieve pristine production levels. Estimates of the number of natural-origin spring chinook returning to Leaburg Dam are available since 1994 when adults from releases of hatchery reared smolts above the dam were no longer present. The number of natural-origin fish at the Dam has increased steadily from 800 in 1994 to about 1,400 in 1998 and 1999 (Table 4). Additional spawning in areas below the Dam accounts for about 20% of the McKenzie return.

The Clackamas River currently accounts for about 20% of the production in the Willamette Basin. The production comes from one hatchery and natural production areas located primarily above the North Fork Dam. The interim escapement goal for the area above the Dam is 2,900 adults (ODFW 1998a). This system is heavily influenced by hatchery production so it is difficult to distinguish natural from hatchery-origin spawners. Most of the natural spawning occurs above the North Fork Dam with 1,000-1,500 adults crossing the Dam in recent years. There were 380 redds counted above the dam in 1998 and similar counts in 1997 (Lindsay et. al. 1998). There is some spawning in the area below the Dam as well although the origin and productivity of these fish is again uncertain. There were 48 spring chinook redds counted below the North Fork Dam in 1998.

Over 70% of the production capacity of the North Santiam system was blocked by the Detroit Dam. There are no passage facilities at the Dam so all of the current natural production potential remains downstream. The remaining habitat is adversely affected by warm water and flow regulation. The system is again influenced substantially by hatchery production, although the original genetic resources have been maintained since Marion Forks Hatchery stock has been derived almost exclusively from North Santiam brood sources (ODFW 1998a). Despite these limitations there continues to be natural spawning in the lower river. There were 194 redds counted in the area below Minto Dam (the lower-most dam) in 1998 and 221 in 1999, compared to an average of 140 in the previous two years (ODFW 2000). The origin of the spawning adults or their reproductive success has not been determined.

Mitigation hatcheries were built to offset the substantial habitat losses resulting from dam construction and, as a result, 85%-95% of the production in the basin is now hatchery origin fish. On the one hand these hatchery populations represent a risk to the ESU. The genetic diversity of the ESU has been largely homogenized due to the past practice of broodstock transfers within the basin. Domestication is also a risk given the predominance of hatchery fish. Nevertheless, the hatchery populations also represent a genetic resource. All five of the hatchery stocks were included in the ESU and therefore are available to support recovery efforts. Given the extensive network of dams in the basin and other pervasive habitat degradations, it is clear that most, if not all, of the remaining populations would have been eliminated had it not been for the hatchery programs.

NMFS is currently engaged in a consultation to consider the future operation of the hatchery facilities in the Willamette Basin. This will reduce future risks associated with hatchery operations. Substantial efforts have already been taken to remedy some of the past hatchery practices including limiting the proportion of hatchery spawners in some natural production areas and reincorporating local-origin wild fish into the hatchery broodstock (ODFW 1998a). All hatchery produced fish in the Basin are now externally marked. Once these fish are fully recruited, the mass marking will greatly improve the managers' ability to monitor and control hatchery straying and production. The marking program will also. allow implementation of selective fisheries in terminal areas and thus provide harvest opportunity with limited impacts to natural origin fish. The fall chinook hatchery production program was also noted as a risk to the species since fall chinook were not historically present above Willamette Falls. The fall production program at Stayton Ponds has now been closed with the last release made in 1995. It is reasonable to expect that the return of fall chinook will diminish rapidly as a result.

**Table 4. Run size of spring chinook at the mouth of the Willamette River and counts at Willamette Falls and Leaburg Dam on the McKenzie River (Nicholas 1995; ODFW and WDFW 1998; ODFW 2000). The Leaburg counts show wild and hatchery combined and wild only since 1994.**

| Return Year | Estimated number entering Willamette River | Willamette Falls Count | Leaburg Dam Count Combined | Leaburg Dam Count Wild Only |
|---|---|---|---|---|
| 1985 | 57,100 | 34,533 | 825 | |
| 1986 | 62,500 | 39,155 | 2,061 | |
| 1987 | 82,900 | 54,832 | 3,455 | |
| 1988 | 103,900 | 70,451 | 6,753 | |
| 1989 | 102,000 | 69,180 | 3,976 | |
| 1990 | 106,300 | 71,273 | 7,115 | |
| 1991 | 95,200 | 52,516 | 4,359 | |
| 1992 | 68,000 | 42,004 | 3,816 | |
| 1993 | 63,900 | 31,966 | 3,617 | |
| 1994 | 47,200 | 26,102 | 1,526 | 825 |
| 1995 | 42,600 | 20,592 | 1,622 | 933 |
| 1996 | 34,600 | 21,605 | 1,445 | 1,105 |
| 1997 | 35,000 | 26,885 | 1,176 | 991 |
| 1998 | 45,100 | 34,461 | 1,874 | 1,415 |
| 1999 | 53,900 | 40,400 | 1,909 | 1,383 |
| *2000** | *59,900* | *40,300* | *2,100* | *1,620* |

*preliminary

### *Lower Columbia River Chinook*

The LCR ESU includes spring stocks and fall tule and bright components. The abundance of fall chinook greatly exceeds that of the spring component. Spring-run chinook salmon on the lower Columbia River, like those from coastal stocks, enter freshwater in March and April well in advance of spawning in August and September. Historically, fish migrations were synchronized with periods of high rainfall or snowmelt to provide access to upper reaches of most tributaries where spring stocks would hold until spawning (Fulton 1968, Olsen *et al*. 1992, WDF *et al*. 1993). Fall run fish do not begin entry to the Columbia River until August.

The remaining spring chinook stocks in the LCR ESU are found in the Sandy on the Oregon side and Lewis, Cowlitz, and Kalama on the Washington side. Spring chinook in the Clackamas River are considered part of the UWR ESU. Naturally spawning spring chinook in the Sandy River are included in the LCR ESU despite substantial influence of Willamette hatchery fish from past years since they likely contain all that remains of the original genetic legacy for that system. Recent escapements above Marmot Dam on the Sandy River average 2,800 and have been increasing (ODFW 1998b). Hatchery-origin spring chinook are no longer released above Marmot Dam; the proportion of first generation hatchery fish in the escapement is relatively low, on the order of 10-20% in recent years.

On the Washington side spring chinook were present historically in the Cowlitz, Kalama, and Lewis rivers. Spawning areas were blocked by dam construction in the Cowlitz and Lewis. The native Lewis run became extinct soon after completion of Merwin Dam in 1932. Production in the Kalama was limited by the dams and by 1950 only a remnant population remained. Spring chinook in the Cowlitz, Kalama, and Lewis are currently all hatchery fish. There is some natural spawning in the three rivers, but these are believed to be primarily from hatchery strays (ODFW 1998b). The recent averages (1994-1999) for naturally spawning spring chinook adults in the Cowlitz, Kalama, and Lewis are 235, 222, and 350, respectively (LeFleur 2000). The amount of natural production resulting from these escapements is unknown, but is presumably small since the remaining habitat in the lower rivers is not the preferred habitat for spring chinook. The Lewis and Kalama hatchery stocks have been mixed with out of basin stocks, but are nonetheless included in the ESU. The Cowlitz stock is largely free of introductions and is considered essential for recovery although not listed. The number of spring chinook returning to the Cowlitz, Kalama, and Lewis rivers have declined in recent years, but still number several hundred to a few thousand in each system (Table 5). Hatchery escapement goals have been consistently met in the Cowlitz and Lewis Rivers. The goal has not been met in all years in the Kalama, but WDFW continues to use brood stock from the Lewis to meet production goals in the Kalama. Although the status of hatchery stocks are not always a concern or priority from an ESA perspective, in situations where the historic spawning habitat is no longer accessible, the status of the hatchery stocks is pertinent. The expected returns in 2000 exceed escapement objectives for each of the three Washington tributary systems.

**Table 5. Estimated Lower Columbia River spring chinook tributary returns, 1992-2000.** (ODFW/WDFW 1998, ODFW/WDFW 2000.)

| Year | Sandy R. | Cowlitz R. | Lewis R. | Kalama R. | Total Returns Excluding the Willamette System |
|---|---|---|---|---|---|
| 1992 | 8,600 | 10,400 | 5,600 | 2,400 | 27,200 |
| 1993 | 6,400 | 9,500 | 6,600 | 3,000 | 25,500 |
| 1994 | 3,500 | 3,100 | 3,000 | 1,300 | 10,900 |
| 1995 | 2,500 | 2,200 | 3,700 | 700 | 9,100 |
| 1996 | 4,100 | 1,800 | 1,700 | 600 | 8,200 |
| 1997 | 5,200 | 1,900 | 2,200 | 600 | 9,900 |
| 1998 | 4,200 | 1,100 | 1,600 | 400 | 7,300 |
| 1999 | 3,300 | 1,600 | 1,000 | 1,000 | 7,600 |
| *2000* | | *2,000* | *2,600* | *1,400* | |

There are apparently three self-sustaining natural populations of tule chinook in the Lower Columbia River (Coweeman, East Fork Lewis, and Clackamas) that are not substantially influenced by hatchery strays. Returns to the East Fork and Coweeman have been stable and near interim escapement goals in recent years. Recent 5 and 10 year average escapements to the East Fork Lewis have been about 300 compared to an interim escapement goal of 300. Recent 5 and 10 year average escapements to the Coweeman are 900 and 700, respectively compared to an interim natural escapement goal of 1000 (pers. comm., from G. Norman, WDFW to P. Dygert NMFS, February 22, 1999). Natural escapement on the Clackamas has averaged about 350 in recent years. There have been no releases of hatchery fall chinook in the Clackamas since 1981 and there are apparently few hatchery strays. The population is considered depressed, but stable and self-sustaining (ODFW 1998b). There is some natural spawning of tule fall chinook in the Wind and Little White Salmon Rivers, tributaries above Bonneville Dam (the only component of the ESU that is affected by tribal fisheries). Although there may be some natural production in these systems, the spawning results primarily from hatchery-origin strays.

The LCR bright stocks are among the few healthy natural chinook stocks in the Columbia River Basin. Escapement to the North Fork Lewis River has exceed its escapement goal of 5,700 by a substantial margin every year since 1980 with a recent five year average escapement of 10,000. The forecast in 1999 was for an exceptionally low return of about 2,500.The actual return was about 3,300. The forecast in 2000 is for a return of 3,500. Both of these will result in returns below goal. The low returns in 1999 and 2000 have been attributed, at least in part, to severe flooding that occurred in 1995 and 1996. However, more recent observations suggest that the decline in recent years may be related to a more pervasive decline in survival rates which will have longer-term implications for the stock (R. Kope, NMFS, pers. comm. to P. Dygert, NMFS, 4/4/2000). These observations will be supported if the actual and projected returns continue to be below goal. Pending confirmation of the new survival data, this population is considered healthy.

There are two smaller populations of LCR brights in the Sandy and East Fork Lewis River. Run sizes in the Sandy have averaged about 1000 and been stable for the last 10-12 years. The fall chinook hatchery program in the Sandy was discontinued in 1977, which has certainly reduced the number of hatchery strays in the system. There is also a late spawning component in the East Fork Lewis that is comparable in timing to the other bright stocks. The escapement of these fish is less well documented, but it appears to be stable and largely unaffected by hatchery fish (ODFW 1998b).

*Puget Sound Chinook*

This ESU encompasses all runs of chinook salmon in the Puget Sound region from the North Fork Nooksack River in the east to the Elwha River on the Olympic Peninsula. Chinook salmon in this area all exhibit an ocean-type life history. Although some spring-run chinook salmon populations in the Puget Sound ESU have a high proportion of yearling smolt emigrants, the proportion varies substantially from year to year and appears to be environmentally mediated rather than genetically determined. Puget Sound stocks all tend to mature at ages 3 and 4 and exhibit similar, coastally-oriented, ocean migration patterns.

The 5-year geometric mean of spawning escapement of natural chinook salmon runs in North Puget Sound for 1995-99 is approximately 18,000. Although long- and short-term trends for these runs were predominately negative, the North Fork Nooksack, Stillaguamish and Snohomish systems have shown improvements in escapements since 1996[2] (Table 7). In South Puget Sound and Hood Canal, the 5-year geometric mean of spawning escapement of the natural runs has averaged 13,000 spawners (Table 7). In this area, both long- and short-term trends are predominantly positive, however, the contribution of hatchery fish to natural escapements in this region may be substantial, masking the trends in natural production. Research projects are underway to determine the degree of hatchery contributions to natural escapements, and the amount of natural production.

Puget Sound chinook is the largest and most complex ESU that is considered in detail in this opinion. WDF *et al.* (1993) identified 28 stocks that were distributed among five geographic regions and 14 management units or basins (Table 6). (The Hoko River stock was included in the initial inventory, but was subsequently assigned to the neighboring ESU.) NMFS is currently engaged in delineating the population structure of PS chinook and other ESUs as an initial step in a formal recovery planning effort that is now underway. These determinations have not been finalized at this time, but it is clear that these 28 stocks represent the greatest level of potential stratification and that

[2] NMFS' status review of west coast chinook (NMFS 1998), including stocks within the Puget Sound ESU, was completed in 1997, and therefore, only considered escapements through 1996.

some further aggregation of these stocks is likely (M. Ruckelshaus, NWFSC/NMFS, pers. com. to S. Bishop, NMFS, March 21, 2000). By considering at this time the status of the stocks as described by WDF *et al.*, NMFS can be reasonably certain that we are not overlooking population structures that may be important to the ESU.

Puget Sound includes areas where the habitat still supports self-sustaining natural production of chinook, areas where habitat for natural production has been irrevocably lost, and areas where chinook salmon were never self-sustaining. In some areas indigenous local stocks persist, whereas local stocks in other areas are a composite of indigenous stocks and introduced hatchery fish that may or may not be of local origin. In some areas where natural production has been lost, hatchery production has been used to mitigate for lost natural production. In response to these varied circumstances, the state and tribal co-managers have developed a proposal to stratify stocks to provide a context for analyzing actions and considering recovery efforts. This stratification was initially proposed in conjunction with a now ongoing consultation regarding hatchery activities in Puget Sound. However, the proposal is broadly applicable and used in this consultation as well, thus providing a common framework for analyzing both harvest and hatchery activities. Although this stratification scheme has not been formally adopted by the co-managers, it nonetheless provides a useful construct for analysis.

The stratification assigns stocks to one of three categories:

Category 1 stocks are genetically unique and indigenous to watersheds of Puget Sound. Maintaining genetic diversity and integrity of these stocks and achieving abundance levels for long-term sustainability is the highest priority for these stocks. Nineteen stocks have been identified in this category (Table 6).

The status of these stocks varies. Some stocks (Dungeness and Nooksack) have fallen to such low levels that our ability to maintain their genetic diversity may be at risk. Other stocks are more robust and the abundance levels are above what is needed to sustain genetic diversity, but often not at levels that will sustain maximum yield harvest rates. All of these stocks have natural spawning escapement goals, which are actively managed for, but have not generally been achieved in recent years. In some cases (Elwha, Dungeness, Nooksack, Stillaguamish, and White River) hatchery operations are essential for recovery, and without them, the stocks would likely further decline and become extinct. In one case at least (Green River) the number of hatchery fish spawning naturally is a concern, in part because it masks our ability to evaluate the actual productivity of wild fish. The objective for category 1 stocks is to protect and recover these indigenous stocks.

Category 2 stocks are located in watersheds where indigenous stocks may no longer exist, but where sustainable stocks existed in the past and where the habitat could still support such stocks. These are primarily areas in Hood Canal and South Sound where hatchery production has been used to mitigate for natural production lost to habitat degradation. Consequently, these areas have been managed for hatchery production and harvest for many years. Natural spawning in these systems continues, but is primarily the result of hatchery-origin strays. Stocks have been preliminarily assigned to Category 2 based on current information, but further investigations will seek to identify remnant indigenous stocks which, if found, would cause them to be reassigned to Category 1. The objective for Category 2 stocks is to use the most locally-adaptable stock to reestablish naturally-sustainable populations.

Category 3 stocks are generally found in small independent tributaries of Puget Sound that may now have some spawning, but never had independent, self-sustaining stocks of chinook salmon. Many of these watersheds do not have the morphological characteristics needed for chinook and may be better suited for coho and chum salmon, cutthroat trout or resident species. Chinook salmon that are observed occasionally in these watersheds are primarily the result of hatchery strays. The objective for these systems is directed at habitat protection to ensure the production of other species, but no specific actions are proposed to promote the natural production of chinook salmon.

This opinion considers whether the proposed harvest regime 1) adequately protects the geographic distribution and life histories of natural populations within the Puget Sound ESU; 2) protects a significant proportion of the remaining genetically unique and indigenous salmon populations, and; 3) does not appreciably increase the demographic and genetic risks to populations currently considered to be in critical status and necessary to the protection of the ESU.

Based on this framework, Category 1 stocks are therefore the core stocks that provide the focus for the analysis of proposed harvest actions in this biological opinion. Consideration of management impacts to Category 2 stocks is necessary in areas that are not adequately represented by Category 1 stocks. In addition, harvest constraints designed to protect Category 1 stocks will benefit Category 2 stocks as well. In the future, Category 2 stocks may warrant more targeted protections however, they, by definition, occur in watersheds where indigenous stocks no longer exist. Therefore, this opinion considers whether management actions are consistent with the stated objective of promoting establishment of naturally-sustainable populations. Future decisions regarding the form and timing of recovery efforts in these watersheds will dictate the kinds of harvest actions that may be necessary and appropriate in the future.

Circumstances pertinent to the status of each of the Category 1 stocks varies considerably. Their status ranges from healthy to critical; some stocks are severely limited by the available habitat. The range of hatchery influence varies from completely dependant to stocks that are largely unaffected by hatchery strays. These circumstances are pertinent to the consideration of the kinds of harvest management constraints that are necessary and appropriate. Following is therefore a brief review of factors relevant to the status of each of the Category 1 stocks and the major Category 2 stocks in regions not fully represented by Category 1 stocks.

**Table 6. Distribution of stocks identified in WDF et al. (1993) by recovery category. Stock timing designations are spring (SP), summer (S), fall (F), and summer/fall (SF).**

| Region | Management Unit | Stock/Timing | Recovery Category |
|---|---|---|---|
| Strait of Juan de Fuca | Elwha River | Elwha/Morse Cr./SF | 1 |
| | Dungeness River | Dungeness/SP | 1 |
| Hood Canal | Mid-Hood Canal | Hood Canal/SF -Tribs and Skokomish River | 2 & 3 |
| | Skokomish River | | 2 |
| North Sound | Nooksack Early | NF Nooksack/SP<br>SF Nooksack/SP | 1<br>1 |
| | Nooksack/Samish | Nooksack/F | 2 |
| | Skagit Spring | Upper Sauk/SP<br>Suiattle/SP<br>Cascade/SP | 1<br>1<br>1 |
| | Skagit Summer/Fall | Upper Skagit/S<br>Lower Skagit/F<br>Lower Sauk/S | 1<br>1<br>1 |
| | Stillaguamish | Stillaguamish/S<br>Stillaguamish/F | 1<br>1 |
| | Snohomish | Snohomish/S<br>Wallace/SF<br>Snohomish/F<br>Bridal Veil Cr/F | 1<br>2<br>1<br>1 |
| Mid-Sound | Lake Washington | Issaquah/SF<br>N Lake WA Tribs/SF<br>Cedar/SF | 2<br>2<br>1 |
| | Green River | Duwamish/Green/SF<br>Newaukum Cr/SF | 1<br>1 |
| South Sound | White River Spring | White River/SP | 1 |
| | Puyallup | Puyallup River /SF | 2 |
| | Nisqually | Nisqually River/SF | 2 |
| | South Sound Tribs | South Sound Tribs/SF | 3 |

Elwha River Summer/Fall Chinook

Elwha chinook is one of the most genetically distinct stocks in Puget Sound (Myers *et al.* 1998). The Elwha River originates in the Olympic Mountains. Much of the drainage is still pristine and protected in the Olympic National Forest. Two dams at river miles 4.9 and 13.4 block passage to over 70 miles of potential habitat. The remaining habitat below the first dam is degraded by the loss of natural gravel, large woody debris, and the adverse effects of high water temperatures. The high temperatures exacerbate problems with the parasite *Dermocystidium*; resulting prespawning mortality is sometimes as high as 70%.

Because of limitations on natural production, the hatchery and naturally spawning stocks are fully integrated, and the hatchery population is listed. Hatchery-origin fish commonly spawn in the river and broodstock is routinely supplemented by collecting adults from the river. No out-of-basin hatchery stocks have been brought into the basin in recent years and the stock is considered unaffected by the few transfers that were made in earlier years. The escapement to the system has averaged about 2,000 over the last five years (range 1,606-2,527) compared to an escapement goal of 2,900. However, the goal is largely a hatchery production goal and does not represent the natural production capacity of the current degraded habitat. Considering the current level of degradation in habitat quality and quantity, the population would likely become extinct without the continued contribution of the hatchery stock.

Dungeness River Spring/Summer Chinook

Dungeness chinook are considered distinct based on their spawn timing and geographic distribution. The Dungeness River is located in a rain shadow and as a result receives relatively little rainfall (less than 20 inches per year). The Dungeness is therefore particularly dependent on annual precipitation and snow pack and is susceptible to habitat degradations that exacerbate low flow conditions. Agricultural water withdrawals remove as much as 60% of the natural flow during the critical low flow period which coincides with spawning. Other land use practices have also substantially degraded the system. The geometric mean of the escapement has been 104 over the last five years (range 50-183) compared to an escapement goal of 925 (Table 7). Dungeness River chinook are considered critically depressed. As a result, a captive brood stock program was initiated in 1992 to maintain an egg bank to reduce the risk of extinction and help rebuild the native run. In the last couple of years juvenile releases from the program have been on the order of two million; a variety of release strategies are being tested to evaluate which approach is most effective. Significant contributions to escapement from the captive brood stock program are anticipated in 2000.

Nooksack River Spring Chinook

The Nooksack River has two distinct natural spawning stocks in the North Fork and South Fork. These stocks are genetically distinct from each other and all other Washington stocks as well. The stocks have differentiated because of the unique characteristics of the two watersheds. The North Fork is a higher elevation glacier fed stream; the South Fork is a lower elevation stream that receives no glacier melt. The South Fork is therefore generally low and clear during spawning. Adaptation to these diverse water flow patterns reinforces the biological isolation of these stocks despite their proximity. There is apparently little straying between the two as indicated by the very few out-of-basin coded-wire tag (CWT) recoveries. Because of the unique characteristics of these stocks, both are considered important to the overall health and recovery of the PS chinook.

Both stocks are depressed due to low spawning in recent years and the South Fork in particular is likely critical. Over the last five years the geometric mean of escapements to the North Fork and South Fork has 481 (range 230-911) and 204 (range 157-290), respectively compared to interim escapement goals of 2,000 each (Table 7). Although South Fork escapements have continued to decline, escapements to the North Fork have improved since 1997. The North Fork and South Fork have been substantially degraded due largely to timber harvest and associated road building activities. Improvements in habitat quality are considered essential to recovery.

A hatchery program on the North Fork has operated since 1988; the North Fork hatchery stock is considered essential to recovery. There is both an on-station program to maintain broodstock and a system of off-station acclimated release sites to supplement the natural production. Returns from the supplementation program have contributed to escapements in recent years thus helping to reduce the immediate risks associated with very low returns. Early supplementation efforts on the South Fork proved unsuccessful and were discontinued. There is currently no supplementation program in the South Fork.

Skagit River Spring Chinook

The Skagit watershed is the largest in Puget Sound, contributing over 20% of the freshwater flowing into Puget Sound. The Skagit has several major stream systems that differ substantially in terms of geomorphology and hydrography. Because of this diversity, six different stock groups are recognized including three spring stocks on the upper Cascade, Sauk, and Suiattle Rivers. The spring stocks occupy the upper portions of the watersheds where the gradients are moderate to high and water temperatures are generally cooler. The aggregate escapement goal for the spring stocks is 3,000. The combined escapements in recent years have been about 1,000, but returns have been reasonably well distributed and stable in each system. Each year the Chinook Technical Committee (CTC) of the Pacific Salmon Commission assesses whether a subset of Canadian and U.S. chinook stocks are rebuilding according to a schedule adopted by the Pacific Salmon Commission. This schedule is based on the rate of increase required to achieve escapements above goal by 1998[3]. Therefore, if a stock were rebuilding at a slower rate it would not be considered rebuilding by the CTC. In addition, most recent assessment only considered escapements through 1996, so any improvements since that time would not be reflected in the assessment. However, the analysis provides a generally applicable assessment of escapement trends for a subset of Puget Sound stocks. The CTC has classified Skagit River spring chinook as not rebuilding (CTC 1999). The geometric mean of escapements to the Cascade, Sauk, and Suiattle Rivers over the last five years has been 208 (range 83-323), 262 (range 180-408), and 381 (range 208-473)(Table 7). Critical threshold escapement levels have not been identified for these stocks in particular. Escapements have been close to the generic critical guideline of 200 for the Upper Sauk and Upper Cascade in two of the five years. The co-managers classified the stock status of the Upper Cascade spring stock as "Unknown", the Upper Sauk spring stock as "Healthy" and the Suiattle spring stock as "Depressed"

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[3] For Puget Sound stocks, the 1984-1996 period was assessed against the 1979-82 base period.

(WDF *et al.* 1993) based on escapement data through 1991. Revisions in escapement estimation methodology in 1994 raise questions about the accuracy of the earlier estimates. In general, the estimates of recent years' escapements from the two methods are significantly different. However, comparisons between escapements estimated under the old and new methods have not demonstrated any bias between the two methods.

The Skagit spring stocks are relatively unaffected by hatchery production. There is a spring chinook hatchery stock on the Cascade River that is used as an indicator stock for harvest and marine survival estimates. As a result, all fish released are coded wire tagged. The program was originally intended to supplement natural production, but it has not been used for that purpose.

<u>Skagit River Summer/Fall Chinook</u>
The Skagit also supports summer stocks on the lower Sauk and upper Skagit and a fall stock on the lower Skagit. The status of these stocks varies although all have declined in abundance over the last 20-25 years. The aggregate escapement goal for the Skagit summer/fall management unit is currently 14,900. However, more recent analysis, including that associated with this opinion suggests that a MSY goal of about 9,000 is more consistent with the available information. The combined geometric mean of spawning escapements of the three Skagit summer/fall stocks has been 7,910 in the last five years. The stock specific escapements for the lower Sauk, upper Skagit, and lower Skagit have averaged 410 (range 263-1,103), 6,087 (range 3,586-11,761), and 1,006 (range 409-2,388), respectively (Table 7). Escapements to the lower Sauk have been less than 300 in four of the last six years and so are likely at least approaching critical levels. The lower Skagit stock is depressed although the abundance in recent years is likely well above threshold levels. The upper Skagit stock is the most abundant and productive component with escapements that are routinely approaching and occasionally exceeding MSY levels. The CTC classified these stocks as not rebuilding (CTC 1999). The Skagit summer/fall stocks are also largely unaffected by hatchery production. There are again harvest and survival rate indicator stock programs for both Skagit summer and fall chinook that involve the collection of 40 spawning pairs per year and the release of about 200,000 marked juveniles for each of the two programs.

<u>Stillaguamish Summer/Fall Chinook</u>
Two stocks are distinguished in the Stillaguamish River. There is a summer chinook stock in the North Fork Stillaguamish and a fall chinook stock in the South Fork. The geometric mean aggregate escapement to the system over the last five years has been 1,174 (range 822-1,544) compared to an combined escapement goal of 2,000 (Table 7). However, the distribution of escapement has been uneven with most fish returning to the North Fork. Escapements to the South Fork have averaged just 229 over the last five years (range 176-253) and have been less than 253 since 1985. Although still low, the escapements of the last three years are the highest since 1985. Escapements in the North Fork showed a similar upward trend. Although there appears to be some improvement, the rate of improvement is lower than that of the PSC chinook rebuilding program, so the CTC has classified it as not rebuilding. However, the potential benefits of management actions taken in the terminal area to protect the Stillaguamish stock, and the most recent increases in escapements, are not reflected in the assessment because of data limitations (CTC 1999).

There is a supplementation program in place for Stillaguamish summer chinook which is considered essential for recovery. The program was initiated in 1980. There is no on-station release program; rather brood stock is collected annually from the river (the collection goal is 65 pairs) to provide for a release of 200,000 juveniles. The hatchery-origin fish are all marked and also serve as a harvest and survival indicator stock. The marking also means that returning hatchery fish can be distinguished from natural-origin spawners for assessment purposes. Juveniles are acclimated and released volitionally from a large, spring-fed rearing pond. The program contributes a significant proportion of the annual escapement and is at least partly the reason why escapements to the North Fork Stillaquamish have been higher than those in the South Fork. The composition of the spawners in the South Fork is unknown. Field data will be collected beginning in 2000 that should provide some indication of the contribution of hatchery spawners to the South Fork fall stock.

Production in both systems is limited substantially by poor habitat conditions.

<u>Snohomish Chinook</u>

There are three Category 1 stocks in the Snohomish watershed, including Snohomish summer chinook that spawn in the Skykomish and Snohomish mainstems, Bridal Veil chinook which spawn in Bridal Veil Creek and in the North and South Fork Skykomish Rivers, and Snohomish fall chinook that spawn in the Sultan and Snoqualmie rivers and associated tributaries. There is a fourth population that spawns in the Wallace River that is associated with the Skykomish hatchery. The naturally spawning adults in the Wallace River are primarily hatchery origin. This is the only chinook production facility in the Snohomish Basin. Hatchery strays apparently also contributed substantially to the Bridal Veil spawning escapement in 1997 and 1998. Hatchery contribution to the rest of the system has been extremely variable (K. Rawson, Tulalip Tribal Fisheries, pers. comm. to S. Bishop, NMFS, April 10, 2000).

The Snohomish system has a combined naturally spawning escapement goal of 5,250. The average escapement over the last five years has been 4,719 (range 3,707-6,306) (Table 7). The escapement of 6,306 in 1998 is the first time the goal has been met since 1980, and escapements have generally improved since 1997. The distribution of spawners has also been relatively even across the four stocks with none that suggest critical stock concerns. Returns have been relatively stable, falling below 3,000 only twice since 1968.

<u>Lake Washington Chinook</u>

The Cedar River is the only Category 1 stock in the Lake Washington system. Natural spawning occurs in Issaquah Creek, but this is supported primarily by releases from the Issaquah Hatchery which is a harvest-oriented production facility. Additional spawning occurs in several small tributaries that enter north Lake Washington including Big Bear Creek and Cottage Lake Creek. These are considered Category 2 populations at this time, although GSI data are being collected to identify whether any remnant indigenous population remains.

Production in the Cedar River is limited by a water diversion dam at river mile 21 which blocks passage to the upper watershed. Natural production is further limited by stream flows, physical barriers, poor water quality and limited spawning and rearing habitat related to watershed development.

The escapement goal for the Cedar River is 1,200 naturally spawning adults and 350 for the combined north Lake Washington tributaries. Escapement over the last five years has averaged 630 (range 294-930) primarily in the Cedar River (Table 7). Escapements in the last three years have averaged only 0.64 of the 1988-1996 average. The level of hatchery straying in the Cedar River is unknown, but probably contributes very little given the uniqueness of the genetic profile and the distance from the nearest hatchery. However, hatchery strays are believed to contribute significantly to escapement in the northern tributaries of Lake Washington (WDFW *et al.* 1993).

Green River Chinook

There is one Category 1 stock identified in the Green River system. (The lower 10 miles of this drainage are referred to as the Duwamish; the upper portion of the drainage is known as the Green River.) The Green River population has two components; summer/fall chinook spawn from river mile 25-61 in the Green River, and an aggregation of summer/fall chinook that spawn in Neuwakum Creek. There is a large hatchery program at the Green River Hatchery on Soos Creek. The Green River Hatchery stock was founded using Green River origin fish and was the primary production stock that was distributed throughout Puget Sound in past years. (This practice of cross-basin transfers has now been largely eliminated.) There is considerable straying of the hatchery-origin fish into the Green River, but because there have been no out-of-basin stock transfer, this integrated Green River natural/hatchery-origin stock presumably retains most of is genetic characteristics. This assumption is supported by current GSI data, which shows no genetic distinction between between hatchery-reared and naturally-spawning adults (Marshall unpublished).

The natural escapement goal for the Green River system is 5,800 chinook. The geometric mean of escapements has been 7,946 (range= 6,026-9,967) over the last five years, comprising the highest consecutive years of escapement observed (Table 7). However, this includes an unknown, but presumably substantial number of hatchery strays.

White River Spring Chinook

The only Category 1 population in south Puget Sound is White River spring chinook. The White River is a tributary of the Puyallup River. White River spring chinook are the last remaining spring chinook population in south Puget Sound. The stock is genetically distinct from all other Puget Sound stocks including neighboring summer/fall stocks. It is also distinguished from its neighbors by its life history characteristics.

The abundance of White River spring chinook reached critically low levels in the late 70s and early 80s; returns averaged just 60 fish over a period of 10 years and were below 30 for five years running. As a result, White River spring chinook have been the subject of an intensive rebuilding program since the 1970's. A hatchery program was developed that includes both juvenile on-station releases and a full life-cycle captive brood stock program. Juvenile production is also released from acclimation sites in the upper watershed. Although the on-station releases are all identifiable, the mark rate of the acclimation site releases varies widely. The hatchery population is considered essential for recovery and the rebuilding program has been successful at substantially increasing the annual returns over the years. A diversion dam adjacent to the White River Hatchery blocks anadromous access to the upper watershed. However, all unmarked returns are passed above the dam in order to maximize natural production and habitat utilization. The natural escapement is comprised of these unmarked returns and a small number of fish that spawn just downstream of the diversion dam. The current annual natural escapement goal is for 1,000 adult spawners passed above the dam. The geometric me of natural escapements has been 484 over the last five years (range 316-630) (Table 7). Although this includes some contribution from the acclimation site returns, it is believed to be low (D. Brown to S. Bishop, pers. com., 4/6/00). A number of significant habitat related problems will have to be addressed before the population can be weaned of its dependence on the supplementation program.

Puyallup River Fall Chinook

Puyallup chinook are currently classified as a Category 2 stock. The co-managers had tentatively identified a second summer/fall stock spawning in the White River (WDFW *et al.* 1993). However, subsequent collections of GSI data, indicated that it was identical to White River spring chinook. Chinook spawn naturally throughout the Puyallup system, with the majority of the spawning occurring in South Prairie Creek. Although most of the known spawning area is surveyed annually, the glacial nature of the system makes it difficult to accurately assess spawning in areas outside South Prairie Creek (WDFW/PTF in review). Puyallup chinook have been significantly impacted by large hatchery releases of Green River origin chinook. Although this practice of cross-basin transfers has been eliminated and off-station releases are no longer made into areas of natural production, available GSI analysis indicates no significant genetic difference between the Puyallup and Green River fall chinook stocks (WDFW/PTF in review). There are two hatcheries on the Puyallup system that release chinook annually, and considerable straying of the hatchery-origin fish into the Puyallup may occur. Plans are in place to mark 100% of hatchery releases and collect DNA samples from the Puyallup Basin to determine hatchery stray rates and whether any remnant of the native stock exists. Habitat has been significantly degraded due to flood control practices, timber harvest and residential, industrial and commercial development. The upper watershed is currently inaccessible to anadromous species above a water diversion dam at RM 41.7. However, a fish ladder is scheduled for completion in October of 2000.

Until recently, the naturally spawning escapement goal for Puyallup fall chinook was 3,250 chinook[4], but the system was managed primarily to achieve hatchery escapements. The geometric mean of the naturally spawning adult escapements have averaged 2,673 (range= 1,554-4,995) over the last five years (Table 7), and have improved, on average, since 1997. However, this includes an unknown, but presumably substantial number of hatchery strays. There is a great deal of uncertainty about the accuracy of the escapement estimates for the system as a whole (WDFW/PTF in review). As a result, the co-managers have proposed revising the management objectives to include only escapement to South Prairie Creek and a 50% maximum exploitation rate for the system. South Prairie Creek would be treated as an index for the system. That is, escapement for the system would

[4] This goal was never jointly agreed to between the Washington Department of Fish and Wildlife and Puyallup Tribe. A recent review of the escapement goal methodology uncovered an error in the expansion from the index area. The corrected value would have been 1,900 (WDFW/PTF in review).

be assumed to be sufficient, if escapement to South Prairie Creek was met.

Nisqually River Fall Chinook

The Nisqually River is the other large river system in South Sound that historically produced chinook. Summer/fall chinook in this system are currently classified as a Category 2 stock. Nisqually chinook spawn primarily in the mainstem of the river.

Nisqually chinook have also been significantly affected by large hatchery releases of Green River origin chinook, although this practice of cross-basin transfers has now been largely eliminated. There are two tribal hatcheries on the Nisqually system, and a WDFW facility on McCallister Creek (a nearby stream) that release chinook annually, and there is probably considerable straying of the hatchery-origin fish into the Nisqually. GSI data are being collected to determine whether any remnant of the native stock exists.

Like the Puyallup River, the Nisqually River is a glacially-fed river system, which makes it difficult to accurately assess salmon escapement. The escapement goal was updated in 1999 as part a recovery plan under development by the co-managers. The interim natural escapement goal for Nisqually fall chinook is 1,100 chinook, based on an extensive assessment of habitat conditions. This goal is proposed to be effective through 2003, but may change as per the recovery plan (Nisqually EDT Work Group 1999). The geometric mean of naturally spawning escapements has been 611 (range= 340- 1730) over the last five years (Table 7). The 1997-1999 average escapement has been one-half of the 1988-1996 average. However, this includes an unknown, but presumably substantial number of hatchery strays.

Skokomish River Fall Chinook

The Skokomish River is considered a Category 2 populations and was historically the largest chinook producer in Hood Canal. Natural production in the North Fork Skokomish has been limited as a result of impacts associated with a hydroelectric dam that blocks anadromous passage at RM 21 and greatly limited in-stream flow due to an out of basin diversion. Natural production in the South Fork is further limited by the effects of intensive logging activity (WDF *et al.* 1993).

Natural production also occurs in several smaller river systems in Hood Canal. All these areas have been influenced by releases of Green River chinook. All these stocks are considered either Category 2 or Category 3 populations at this time, although GSI data are being collected to identify whether any remnant indigenous population remains.

The natural escapement goal for the Skokomish River is 1,650 naturally spawning adults. However, Hood Canal chinook has been a hatchery management area managed to achieve a combined natural/hatchery escapement goal of 3,150. The geometric mean of naturally spawning adult escapement over the last five years has averaged 1,087 (range= 452-1,817) (Table 7). However, this includes an unknown, but presumably substantial number of hatchery strays. Although natural escapement has been relatively stable since 1988, the proportion of the total escapement comprised of naturally spawning adults (for escapements of similar size) appears to have declined since 1994.

**Table 7 . Escapement by stock within the Puget Sound ESU.**

| Year | Dungeness | NF NKS | SF NKS | Upper Sauk Spring/1 | Suiattle Spring/1 | Upper Cascade Spring/1 | Lower Sauk Summer | Lower Skagit Falls | Upper Skag Summer | Stillaguamish S/F | Snohomish | Cedar | Green | White R | Puyallup | Nisqually | Skokomish Total | Skokomish Natural |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 610 | 1,468 | | | | | 362 | 7,822 | 471 | 5,832 | 393 | 2,220 | 800 | 3,423 | 2,666 |
| 1972 | | | | 150 | 1,804 | | | | | 322 | 3,128 | 419 | 4,343 | 392 | 925 | 700 | 2,119 | 1,066 |
| 1973 | | | | 1,255 | 577 | | | | | 3,638 | 4,841 | 1,025 | 3,180 | 137 | 630 | 700 | 3,093 | 1,572 |
| 1974 | | | | 108 | 355 | | 1,082 | 3,116 | 8,389 | 1,013 | 6,030 | 560 | 5,095 | 388 | 1,480 | 500 | 779 | 674 |
| 1975 | | | | 300 | 326 | | 964 | 3,185 | 7,171 | 1,198 | 4,485 | 656 | 3,394 | 488 | 1,396 | 550 | 1,836 | 1,673 |
| 1976 | | | | 173 | 460 | | 1,770 | 5,590 | 6,760 | 2,140 | 5,315 | 416 | 3,140 | 229 | 1,120 | 450 | 1,378 | 1,134 |
| 1977 | | | | 411 | 407 | | 926 | 2,485 | 5,807 | 1,475 | 5,565 | 675 | 3,804 | 66 | 703 | 220 | 2,061 | 1,427 |
| 1978 | | | | 404 | 548 | | 1,640 | 2,987 | 8,448 | 1,232 | 7,931 | 890 | 3,304 | 140 | 962 | 178 | 485 | 164 |
| 1979 | | | | 411 | 344 | | 1,636 | 3,829 | 7,841 | 1,042 | 5,903 | 1,243 | 9,704 | 72 | 2,359 | 1,665 | 1,301 | 1,251 |
| 1980 | | | | 590 | 816 | | 2,738 | 4,921 | 12,399 | 821 | 6,460 | 1,360 | 7,743 | 61 | 2,553 | 1,124 | 997 | 479 |
| 1981 | | | | 394 | 581 | | 1,702 | 2,348 | 4,233 | 630 | 3,368 | 624 | 3,606 | 175 | 518 | 439 | 422 | 117 |
| 1982 | | | | 277 | 476 | | 1,133 | 1,932 | 6,845 | 773 | 4,379 | 763 | 1,840 | 20 | 851 | 848 | 323 | 248 |
| 1983 | | | | 202 | 352 | | 375 | 3,151 | 5,197 | 387 | 4,549 | 788 | 3,679 | 21 | 1,184 | 1,066 | 1,278 | 1,007 |
| 1984 | | | | 238 | 345 | 113 | 680 | 2,306 | 9,642 | 374 | 3,762 | 898 | 3,353 | 7 | 1,258 | 313 | 2,850 | 1,394 |
| 1985 | | | | 1,818 | 716 | 100 | 515 | 1,686 | 13,801 | 1,409 | 4,873 | 766 | 2,908 | 27 | 1,147 | 112 | 5,031 | 2,974 |
| 1986 | 238 | | | 737 | 806 | 380 | 1,143 | 4,584 | 12,181 | 1,277 | 4,534 | 942 | 4,792 | 6 | 740 | 302 | 5,876 | 2,643 |
| 1987 | 100 | | | 815 | 729 | | 792 | 2,635 | 5,982 | 1,321 | 4,689 | 1,540 | 10,338 | 117 | 925 | 85 | 5,449 | 2,112 |
| 1988 | 335 | 450 | 230 | 870 | 740 | 133 | 1,052 | 2,339 | 8,077 | 717 | 4,513 | 559 | 7,994 | 127 | 1,332 | 1,342 | 7,596 | 2,666 |
| 1989 | 88 | 300 | 0 | 668 | 514 | 218 | 449 | 1,454 | 4,781 | 811 | 3,138 | 558 | 11,512 | 83 | 2,442 | 2,332 | 3,760 | 1,204 |
| 1990 | 310 | 10 | 140 | 557 | 685 | 269 | 1,294 | 3,705 | 11,793 | 842 | 4,209 | 469 | 7,035 | 275 | 3,515 | 994 | 2,828 | 642 |
| 1991 | 163 | 110 | 630 | 747 | 354 | 135 | 658 | 1,510 | 3,656 | 1,632 | 2,783 | 508 | 10,548 | 194 | 1,702 | 953 | 4,787 | 1,719 |
| 1992 | 153 | 490 | 100 | 580 | 201 | 205 | 469 | 1,331 | 5,548 | 780 | 2,708 | 525 | 5,267 | 406 | 3,034 | 106 | 1,119 | 825 |
| 1993 | 43 | 440 | 230 | 323 | 292 | 168 | 205 | 942 | 4,654 | 928 | 3,866 | 156 | 2,476 | 409 | 1,999 | 1,655 | 1,572 | 960 |
| 1994 | 65 | 40 | 120 | 130 | 167 | 173 | 100 | 884 | 4,665 | 954 | 3,626 | 452 | 4,078 | 392 | 2,526 | 1,730 | 1,152 | 657 |
| 1995 | 163 | 230 | 290 | 190 | 440 | 225 | 263 | 666 | 5,948 | 822 | 3,707 | 681 | 7,939 | 605 | 2,701 | 817 | 6,594 | 1,398 |
| 1996 | 183 | 540 | 200 | 408 | 435 | 208 | 1,103 | 1,521 | 7,989 | 1,380 | 4,850 | 303 | 6,026 | 630 | 2,440 | 600 | 4,095 | 995 |
| 1997 | 50 | 620 | 180 | 305 | 428 | 308 | 295 | 409 | 4,168 | 1,160 | 4,300 | 227 | 9,967 | 400 | 1,550 | 340 | 2,337 | 452 |
| 1998 | 110 | 366 | 157 | 290 | 473 | 323 | 460 | 2,388 | 11,761 | 1,544 | 6,306 | 432 | 7,300 | 316 | 4,995 | 834 | 6,911 | 1,327 |
| 1999 | 75 | 911 | 213 | 180 | 208 | 83 | 295 | 1,043 | 3,586 | 1,098 | 4,799 | 241 | 9,100 | 553 | | | 10,044 | 1,817 |
| 1988-96 | 139 | 176 | 232 | 425 | 382 | 188 | 470 | 1,405 | 5,963 | 949 | 3,644 | 436 | 6,374 | 289 | 2,322 | 913 | 3,024 | 1,110 |
| 1997-99 | 74 | 591 | 182 | 252 | 348 | 202 | 342 | 1,006 | 5,602 | 1,253 | 5,067 | 287 | 8,716 | 412 | 2,782 | 533 | 5,454 | 1,029 |
| 97-99/88-96 | 0.67 | 3.29 | 0.80 | | | | 0.98 | 0.79 | 1.03 | 1.35 | 1.38 | 0.67 | 1.25 | 1.59 | 1.15 | 0.61 | 1.68 | 0.92 |

/1 The escapement estimation methodology for Skagit spring chinook changed in 1994 and the escapement estimates before and after this change are not comparable.

## III. Environmental Baseline

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR §402.02).

### A. Status of the Species and Critical Habitat within the Action Area

The assessments of the size, variability and stability of chinook and chum populations, described in the previous sections, are made in fresh water spawning and migratory environments and closely reflect the status of the species.

Designated critical habitat for the three chinook and one chum ESU that are the focus of this opinion includes the marine and freshwater areas in Puget Sound, but not the offshore marine areas under the jurisdiction of the PFMC. Marine habitats (i.e., oceanic or near shore areas seaward of the mouth of coastal rivers) are clearly vital to all salmonid species, and ocean conditions are believed to have a major influence on their survival and productivity (see review in Pearcy 1992). However, to date, there has been no apparent need for special management action to protect offshore areas. Marine and freshwater areas of Puget Sound have been affected by a variety of factors. In addition to the impact of harvest that is considered in detail in this opinion, the species of concern are affected by impacts related to habitat degradation, hatchery programs, and hydro-development. The relative effect of each H to the ESUs, and to each stock within an ESU, differs. However, in general, human development associated with forestry, farming, grazing, road construction, mining, and urbanization have all contributed to the decline of the species.

The Puget Sound Salmon Stock Review Group (PSSSRG), a subcommittee of the PFMC, assessed the habitat condition as part of a larger review of several Puget Sound chinook and coho stocks that met the criteria of overfished stocks under the PFMC salmon FMP. While this review only included a subset of Puget Sound chinook stocks, similar habitat impacts are found in most watersheds within the Puget Sound chinook ESU. It reported that reductions in the habitat capacity and habitat quality of the Skagit, Stillaguamish, Snohomish and Strait of Juan de Fuca watersheds have contributed to shortfalls in escapements (PSSSRG 1997). The loss of large woody debris (LWD), critical for creating and maintaining chinook habitat, has exacerbated low flow conditions, resulting in increased sediment load and higher water temperatures. Removal of LWD from Strait of Juan de Fuca streams such as the Pysht (historic volume of LWD reduced by 80%) and Dungeness has significantly reduced summer and winter rearing habitat in these systems. It has been suggested that increased sediment load resulting from a variety of land use practices has contributed to the loss of spawning, early incubation and winter rearing habitat in the Stillaguamish and Strait of Juan de Fuca systems (PSSSRG 1997).

Hydro development also has substantially affected or eliminated some populations or even whole ESUs. In some cases, the effects are direct as the dams block access to spawning and rearing habitat. In other cases, the effects are less direct, but nonetheless significant as they increase downstream and upstream passage mortality, change natural flow regimes, de-water or reduce flow to downstream areas, block the recruitment of spawning gravel, or result in elevated temperatures. For example, hydromodification in the Skagit system has resulted in a loss of 64% of its distributary sloughs and 45% of side channel sloughs.

A habitat assessment conducted by the Point No Point Treaty Tribes and Washington Department of Fish and Wildlife (2000) concluded that channel, riparian forest and sub-estuarine conditions were moderately to severely degraded in all the watersheds in the HCS chum ESU due to a history of logging, road building, rural development, agriculture, water withdrawal, and channel manipulations throughout the ESU. Within Hood Canal, the Big and Little Quilcene, and Skokomish were considered the most degraded watersheds, with the Big Beef, Union and Hamma Hamma River watersheds only marginally better. The Union stock, the only stock considered “healthy” in the HCS chum ESU, is of particular concern because of the rapid urbanization occurring in the watershed. The Tahuya and Dewatto watersheds are considered to be recovering and in good condition which should increase the chances of success for recovery efforts. The other systems in the region are moderately degraded, with areas of good habitat.

An assessment of the habitat in the Strait of Juan de Fuca chum watersheds concluded that these were among the most degraded watersheds in the ESU (PNPT/WDFW 2000). Winter peak and summer low flows, and sediment aggradation are considered problems in the Dungeness, Jimmycomelately and Snow Creeks. Nearshore marine habitat throughout the ESU has also been severely degraded.

The combined effect of multitude of habitat degradations often poses the greatest risk and greatest challenge to species recovery because they are often the result of multiple dispersed actions, each of which must be addressed. Additionally, habitat degradations by their nature can only be remedied over time as the affected systems slowly recover their properly functioning condition.

Actions affecting habitat within the action area which have undergone consultation are expected to improve productivity by restoring habitat to proper function (NMFS 1996a). However, in most cases, it will be a decade or more before the effects are demonstrable. The harvest standards discussed in this opinion were developed under assumptions of current habitat productivity and capacity.

B. Harvest Activities Affecting Listed Species Outside the Action Area

1. Bering Sea/Aleutian Islands Groundfish Fisheries

Salmon are taken incidentally in the Bering Seas/Aleutian Islands (BSAI) and the Gulf of Alaska

(GOA) groundfish fisheries off of the coast of Alaska. NMFS has conducted section 7 consultations on the impacts of fishing conducted under the Bering Sea and Aleutian Islands and Gulf of Alaska Fishery Management Plans (BSAI/GOA FMP) of the NPFMC on ESA listed species and concluded that impacts were low and not likely to jeopardize the listed species (NMFS 1992, 1994, 1995, 1999a, 1999d). The catch of listed UWR spring chinook in the BSAI groundfish fishery is likely to be only a rare event, and the annual catch of PS and LCR tules is estimated to be extremely low. The estimated ER on UWR in the GOA groundfish fishery was estimated to be about 0.3%, and the ER on the LCR ESU to be about 0.7%. However, much of the bycatch of the groundfish fishery is further north and west along the Aleutian Islands. These are therefore likely substantial overestimates of the actual ERs for UWR chinook and the bright component of the LCR chinook ESU in the GOA groundfish fishery. Because of their more southerly distribution, the PS chinook and LCR tules are even less likely to be caught in the GOA groundfish fishery. These conclusions were based on an average total incidental catch of all chinook in the groundfish fisheries of 40,150 and 0.01 chinook/metric ton groundfish (range = 0 to 6 chinook/metric ton groundfish) (1990-1998)(NMFS 1999b). The estimated catch in 1999 was 44,825 (NMFS 2000b). Should the amount of salmon bycatch change substantially, these conclusions should be revisited.

The bycatch in the Canadian groundfish fisheries has been considered in previous consultations on groundfish and salmon fisheries (NMFS 1992, 1999d). The conclusion was that the bycatch of listed species was not likely to be significant assuming that the total annual salmon bycatch in Canadian groundfish fisheries was approximately 28,000 fish per year[5] (NMFS 1999d). Should the amount of salmon bycatch change substantially, these conclusions should be revisited.

2. Alaskan and British Columbia Salmon Fisheries

Salmon fisheries off the coast of Southeast Alaska (SEAK) and British Columbia also impact the listed salmon ESUs considered in this opinion. Historical impacts to the listed ESUs and their component stocks in these fisheries are summarized in Tables 8-18. The SEAK chinook fisheries and the sockeye, pink, chinook and chum fisheries off the coasts of British Columbia will be managed under the terms of the most recent agreement under the Pacific Salmon Treaty (PST). NMFS recently completed an assessment of the current PST agreement (Treaty) as it applied to the SEAK and Canadian BC fisheries and concluded that it did not pose jeopardy to the listed ESUs (NMFS 1999c). The terms of the agreement will be effective through 2008 (2010 for Fraser Panel fisheries). NMFS' assessment involved a retrospective analysis comparing the total observed exploitation rate against the exploitation rate that would have occurred had the agreement been in place and southern U.S. were held to the minimum observed. The retrospective modeling assumed that the SEAK and Canadian fisheries would harvest up to the limit allowed under the treaty. In addition, the Treaty also includes a general obligation for

[5] Assumes bycatch in other gears is similar to that of whiting which is estimated to be approximately 14,000.

each country to reduce exploitation rates in ISBM[6] fisheries on certain stocks if they are not meeting escapement goals. The fisheries as proposed in 2000 meets the general obligation for U.S. fisheries.

NMFS' assessment found that there would have been little change in exploitation rates as result of the Treaty agreement for UWR and LCR bright chinook. Ocean exploitation rates on LCR spring chinook would be reduced from 30-18%, and for LCR tule chinook from 45-30%. Reductions for the Puget Sound ESU generally ranged between 5 and 20 percentage points, although individual reductions were stock and year specific (NMFS 1999c). It should be noted that the basic assumptions in the retrospective analysis of maximum Treaty harvest and minimum southern fisheries may have been overly conservative for the near term. Although SEAK chinook fisheries are expected to harvest up to the maximum allowed under the agreement, Canadian fisheries will most likely continue to be curtailed at least for the next several years due to the severely depressed status of its stocks as has been the case in recent years, including 2000. In addition, changes in southern U.S. terminal area harvest strategies for some ESUs may result in exploitation rates below those assumed in the PST assessment.

Listed sockeye or chum salmon, in general, are unlikely to be caught or encountered given the huge numbers of chum and sockeye from regions outside the listed ESUs migrating through the same area. The majority of chum catch in SEAK summer fisheries occurs beginning in late July through early September in terminal area (near shore) net fisheries targeted on local stocks of maturing adults. However, HCS chum have been substantially impacted by southern BC fisheries. The exploitation rate on the HCS chum ESU has averaged 11.1%, since 1974, but has been much higher in past years (Table 8). Exploitation rates in Canadian fisheries have been reduced to very low levels in recent years as a result of actions taken to protect summer chum and other species, averaging 2.2%. As part of the current agreement, Canada has committed to take actions designed to continue to keep incidental catch of summer chum low. These actions are expected to result in average exploitation rate on the HCS chum ESU in Canadian fisheries of 6.3% (range = 2.3%-8.3%) (PNPT/WDFW 2000) when and if their own fisheries return to less restrictive circumstances.

The ocean distributions for listed steelhead are not known in detail, but steelhead are caught only rarely in ocean salmon fisheries and are, therefore, not likely to be caught in Alaskan fisheries. The total catch of steelhead in Canadian fisheries is low and consideration of the likely stock composition suggests that the catch of listed steelhead is less than 10 per year from the five steelhead ESUs combined (NMFS 1999c).

[6] Individual Stock-Based Management

**Table 8. Exploitation rates on Hood Canal summer chum by fishery aggregate and year (Lampsakis 2000). The terminal area exploitation rates do not apply to the SJF component of the ESU.**

| | Exploitation Rates | | | | |
|---|---|---|---|---|---|
| **Return Year** | **Escapement Rate** | **Terminal** | **WA Preterminal** | **Canada Area 20** | **Total** |
| 1974 | 88.9% | 0.2% | 2.3% | 8.6% | 11.1% |
| 1975 | 70.1% | 24.5% | 1.9% | 3.4% | 29.9% |
| 1976 | 41.5% | 46.5% | 4.5% | 7.5% | 58.5% |
| 1977 | 70.7% | 20.1% | 4.2% | 4.9% | 29.3% |
| 1978 | 80.5% | 14.5% | 2.5% | 2.5% | 19.5% |
| 1979 | 71.1% | 13.4% | 9.8% | 5.7% | 28.9% |
| 1980 | 48.0% | 43.6% | 3.1% | 5.3% | 52.0% |
| 1981 | 48.5% | 28.9% | 9.5% | 13.1% | 51.5% |
| 1982 | 46.7% | 31.0% | 3.6% | 18.7% | 53.3% |
| 1983 | 42.9% | 50.6% | 5.9% | 0.6% | 57.1% |
| 1984 | 60.2% | 32.2% | 1.4% | 6.2% | 39.8% |
| 1985 | 29.0% | 27.3% | 10.1% | 33.6% | 71.0% |
| 1986 | 40.5% | 48.8% | 1.8% | 8.8% | 59.5% |
| 1987 | 45.2% | 46.1% | 2.4% | 6.3% | 54.8% |
| 1988 | 68.1% | 21.2% | 3.2% | 7.5% | 31.9% |
| 1989 | 19.0% | 29.7% | 8.1% | 43.2% | 81.0% |
| 1990 | 39.0% | 25.4% | 2.2% | 33.5% | 61.0% |
| 1991 | 40.6% | 32.0% | 8.8% | 18.6% | 59.4% |
| 1992 | 72.3% | 4.4% | 2.7% | 20.6% | 27.7% |
| 1993 | 87.9% | 1.2% | 6.5% | 4.4% | 12.1% |
| 1994 | 82.2% | 1.0% | 2.6% | 14.2% | 17.8% |
| 1995 | 94.9% | 0.3% | 0.6% | 4.2% | 5.1% |
| 1996 | 97.4% | 0.6% | 0.5% | 1.5% | 2.6% |
| 1997 | 95.9% | 1.7% | 0.4% | 1.9% | 4.1% |
| 1998 | 96.0% | 1.1% | 1.1% | 1.8% | 4.0% |
| 1999 | 99.4% | 0.0% | 0.1% | 0.5% | 0.6% |
| Mean | 64.5% | 21.0% | 3.8% | 10.7% | 35.5% |
| SEmean | 4.7% | 3.4% | 0.6% | 2.2% | 4.7% |
| Percent by Fishery | | 48.2% | 14.0% | 37.8% | |

Note: 1999 data are incomplete. Recreational data not available

## C. Harvest Activities Affecting Listed Species Inside the Action Area

### 1. Washington, Oregon, California Coast Groundfish Fisheries

Salmon are taken incidentally in the groundfish fishery off Washington, Oregon, and California. NMFS has conducted section 7 consultations on the impacts of fishing conducted under the Pacific Coast Groundfish Fishery Management Plan (PCGFMP) on ESA listed species and concluded that impacts on species listed at that time were low and not likely to jeopardize the listed species (NMFS 1996b, 1999a, 1999d). Most salmon caught incidental to the whiting fishery are chinook. (The 1991-99 average annual catch of pink, coho, chum, sockeye, and steelhead in the whiting fishery are approximately 671, 272, 145, 16 and 0, respectively out of an annual catch of 210 metric tons of whiting). The incidental total catch of all chinook in the groundfish fisheries is generally low. The estimated catch of chinook in the whiting fishery for example has averaged 6,182 annually from 1991 to 1999 (NMFS 1999d). The incidental catch of chinook in other components of the groundfish fishery are comparable in magnitude to those in the whiting fishery (NMFS 1996b). This compares to a catch of chinook in the ocean salmon fisheries off the Oregon and Washington coast that has averaged 156,000 annually during the same 1991 to 1999 time frame (PFMC 2000a).

Because the chinook ESUs considered here include north and far-north migrating stocks, the potential for incidental catch of listed chinook in the groundfish fisheries is limited largely to that which occurs off the Washington coast, although some components of the Lower Columbia River ESU are distributed off the Oregon coast as well. The most recent groundfish opinion (NMFS1999d) estimates the catch of PS, LCR brights and UWR chinook to be an occasional event in these fisheries based on an average of 3-5 CWTs recovered per year. The catch rates of LCR spring and tule stocks are probably somewhat higher based on their higher incidence of catch in PFMC salmon fisheries. However, given the generally low total bycatch of chinook, the ER on these stocks was estimated to be <1% (NMFS 1999d). There have been no CWT recoveries of UCRS chinook in the groundfish fisheries off the coasts of Washington, Oregon and California.

### 2. Southern U.S. Salmon Fisheries

Exploitation rates on the HC and SJF components of the HCS chum ESU in southern U.S. fisheries have averaged 27% and 4%, respectively since 1974, but have been much higher in some past years (Table 8). Exploitation rates have been reduced to very low levels in recent years averaging for the Hood Canal and SJF components 1.4% and 0.5%, respectively. These reductions are the result of reductions taken to protect summer chum and other salmon species.

Until recently the exploitation rates on most of the chinook ESUs being considered here have been too high for many of the component stocks and have contributed to their decline particularly because of what we now know about the long-term decline in ocean productivity (see following section). Upper Columbia River spring chinook is an exception. The timing and distribution of these stocks within this ESU is such that ocean harvest mortality is near zero. In-river harvest rates over the last 15 or 20 years have been 10% or less (ODFW/WDFW 1998). The current status of UCRS chinook is therefore largely unrelated to harvest.

The following series of tables shows the magnitude and distribution of exploitation rates for the chinook ESUs or components of the ESUs. The tables show the total adult equivalent exploitation rates by brood year as well as how that exploitation was distributed across the major fisheries. The estimates are based on coded-wire-tag (CWT) recoveries which provides the most direct estimates of exploitation rates. The adult equivalent calculation is a procedure that discounts catch for expect future natural mortality which would occur prior to spawning. The estimates are reported by brood year. For example, the exploitation rate of the 1992 brood accounts for harvest mortality that occurred on age 2-5 fish in years 1994-97. The data are complete through the 1993 brood and 1998 fishery. The 1994 brood is reported, but is incomplete in that the five year old recoveries from the 1999 fishery are not yet available. There is generally a year-long time lag in updating the coast-wide CWT data base necessary to provide these estimates.

Exploitation rates can also be calculated using harvest management models by catch year. These models use the same CWT data to model exploitation rates that occurred in past years. However, once the models are calibrated, they can also be used for management planning purposes to estimate exploitation rates that would be associated with a given fishery structure in a particular year. Because the models are projections, they can be used to characterize exploitation rate trends from past years relative to the most recent years - 1999 and 2000 in this case - that are not available when using the more direct brood year, CWT estimates. In some cases, the model estimates are reported as an index calculated as the ratio of current exploitation rate divided by the 1989-93 average exploitation rate. Model estimates of ER for the 2000 fisheries are also reported.

The total brood year exploitation rate of UWR chinook averaged 0.54 from 1975 through 1990. The average exploitation rate for the more recent 1991-94 broods was 0.26. Upper Willamette River chinook are a far-north migrating stock (Table 9). The ocean harvest occurs primarily in the Alaskan and northern Canadian fisheries. Because of their northerly distribution and earlier return timing, the exploitation rate of UWR chinook in PFMC fisheries is low, averaging 0.01 in past years and 0.00 in the most recent years (Table 9). The exploitation rate in the river fishery is higher, averaging 0.37 through 1990. Harvest in the river fisheries has declined substantially in recent years because of concerns for Snake River spring/summer chinook and other upriver spring stocks. Commercial harvest in the mainstem have been largely eliminated since 1992. The lower river sport fishery has been closed since 1995. Sport fisheries in the Willamette River and the tributaries have been increasingly restrictive as the return of hatchery and wild fish has declined through the 1990s. The Oregon Department of Fish and Wildlife (ODFW) is now implementing a mass marking and selective fishery program that is expected to reduce in-river recreational harvest rates on natural fish by 80% relative to the 1980-96 average once fully implemented in 2002 (Kruzic 1999). UWR chinook are caught rarely in Puget Sound and other coastal terminal marine fisheries (Table 9).

The Lower Columbia River chinook ESU has three components including spring stocks, tule stocks, and far-north migrating bright stocks. These components have different distributions and are subject to different rates of harvest. The time series of ER for the spring component is not currently available, but the model base period (1979-82) ER for Cowlitz spring chinook in PFMC fisheries was 12%.

The total brood year exploitation rates on tule stocks have averaged 0.68 through 1990 although there has been a pattern of decline over that time period (Table 10). Total exploitation rates for the 1991-1994 broods averaged 0.31 (Table 10). The distribution of the tule stocks is more southerly with the ocean harvest concentrated in Canadian and PFMC fisheries. Exploitation rates in the PFMC fishery averaged 0.23 through 1990 and 0.10 for the 1991-94 brood years. The long-term exploitation rate in the river fisheries averaged 0.11 (Table 10). The most recent 4 year average is 0.05. Tules are caught in the Strait of Juan de Fuca and San Juan sport fisheries at very low levels (D. Simmons, NMFS, pers. comm. to S. Bishop, NMFS). The average exploitation rate on LCR tules in Puget Sound, Grays Harbor and Willapa Bay fisheries averaged 0.02 for the 1972-1990 brood years and 0.00 for the most recent brood years (1991-1994)(Table 10).

North Fork Lewis River fall chinook are the primary representative of the bright component of the Lower Columbia River ESU. As noted above this is one of the few healthy wild stocks in the Lower Columbia River. Total exploitation rates have averaged 0.49 through 1990 and 0.28 between 1991-92. This is a far-north migrating stock so the ocean harvest occurs primarily in Alaska and Canada. The long term average exploitation rate in PFMC fisheries is 0.05. The more recent average ER is 0.01. In-river ERs have averaged 0.22 through 1990 and 0.12 in recent years (Table 11). The exploitation rate on North Fork Lewis fall chinook in Puget Sound and other terminal marine area fisheries averaged 0.01 for the 1977-1990 brood years and 0.00 for the most recent brood years (1991-1994).

The PS chinook ESU includes both spring and fall components. Tables 12-18 contain brood year exploitation rates for stocks within the ESU for which CWT data are available. Exploitation rates among the Nooksack Early, Skagit and White River spring stocks have been very similar. The long-term ERs averaged 0.61,0.68, and 0.69, respectively. ERs have declined for the most recent broods (1991-1994), averaging 0.43,0.50,0.49, respectively (Tables 12-14). Most of the harvest occurs in Canadian and Puget Sound fisheries, averaging 0.25, 0.31, and 0.61 over the long term in Puget Sound fisheries. The 1991-1994 brood exploitation rates in Puget Sound have averaged 0.14, 0.24 and 0.48, respectively. The higher exploitation rate on White River springs in Puget Sound may be the result of a delayed rearing strategy as part of the rebuilding program that generally results in high degree of residualization in Puget Sound waters. The Puget Sound spring chinook stocks are subject to little harvest in PFMC fisheries. The long term average ER ranges from 0.01-0.04. The estimated ER for the most recent brood years is 0.00 (Tables 12-14).

The distribution of PS summer/fall stocks is generally similar spring stocks although their timing is such that they are subject to somewhat higher ERs. The long-term average ER has ranged from 0.67 - 0.87 for a subset of the summer and fall stocks. The most recent brood years have been subject to an ER ranging from 0.42-0.70 (Table 15-18). The Green River fall and Stillaguamish summer chinook stocks have been managed for natural escapement objectives, while9 the Skokomish and Nisqually fall stocks have been managed at a hatchery harvest rate. Harvest of PS fall chinook again occurs primarily in Canada and Puget Sound. The long-term average Puget Sound ER ranged from 0.29-0.50, and 0.17-0.58 in the most recent brood years. The long-term average ER in PFMC fisheries ranged from 0.07-0.14 through 1990 and 0.1-0.03 from 1991-93 (Table 15-18).

A time series of model estimates of total exploitation rates are also available for the Puget Sound spring and fall chinook stocks. These are reported as an index relative to the 1989-93 average ER. Although the decline in ER is moderate relative to the 1989-93 base period, Figure 1 indicates that the ER has declined steadily and more substantially since 1983.

There are no other tribal, local, private, or federal harvest actions unrelated to the actions considered in this opinion that substantially affect the environment of listed chinook in the action area. Harvest mortality that occurs in State waters of the action area are explicitly included in the assessment of harvest mortality associated with PFMC and Puget Sound fisheries so do not need to be considered separately here.

Figure 1. Total adult equivalent exploitation rate index for a composite of Puget Sound spring and fall chinook stocks relative to the 1989-93 average ER.

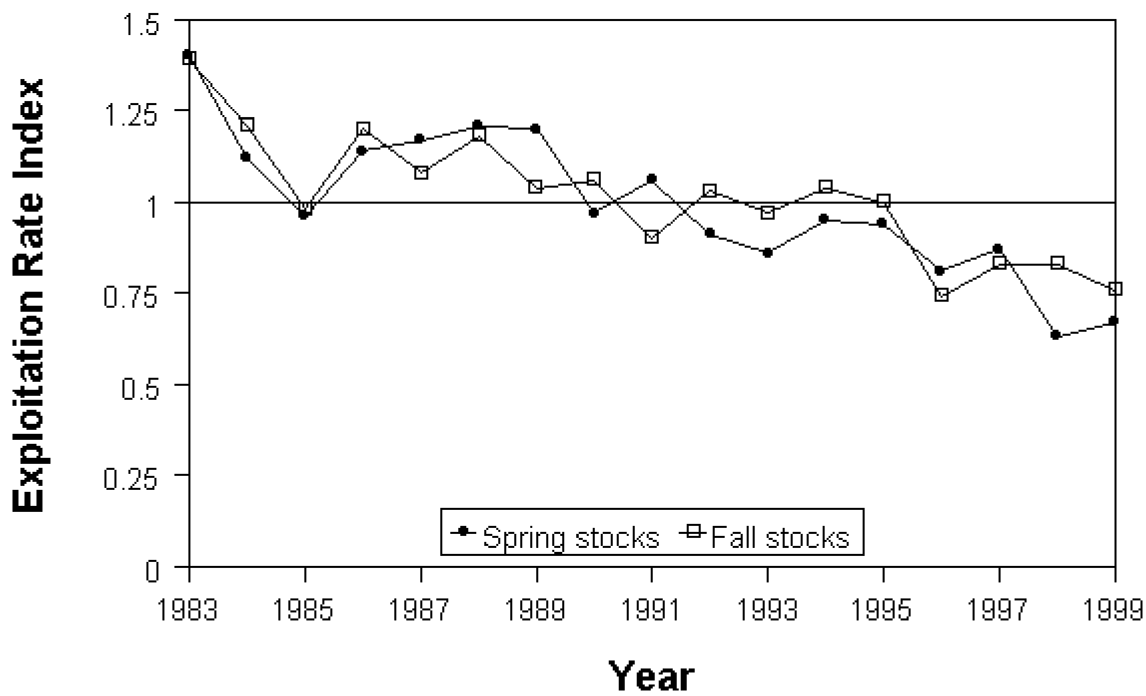


**Table 9. Summary of total adult equivalent exploitation rates for the Upper Willamette River chinook ESU (CTC unpublished).**

| | Willamette Spring Hatchery | | | | | |
|---|---|---|---|---|---|---|
| Brood Year | Total | SEAK | Canada | PFMC | Columbia R. | Other |
| 1971 | | | | | | |
| 1972 | | | | | | |
| 1973 | | | | | | |
| 1974 | | | | | | |
| 1975 | 0.45 | 0.05 | 0.12 | 0.01 | 0.26 | 0.00 |
| 1976 | 0.47 | 0.09 | 0.17 | 0.03 | 0.17 | 0.00 |
| 1977 | 0.55 | 0.09 | 0.14 | 0.02 | 0.30 | 0.00 |
| 1978 | 0.48 | 0.10 | 0.12 | 0.01 | 0.24 | 0.00 |
| 1979 | 0.55 | 0.13 | 0.11 | 0.03 | 0.27 | 0.01 |
| 1980 | 0.46 | 0.06 | 0.07 | 0.01 | 0.32 | 0.00 |
| 1981 | 0.47 | 0.14 | 0.04 | 0.01 | 0.28 | 0.00 |
| 1982 | 0.48 | 0.09 | 0.05 | 0.00 | 0.33 | 0.01 |
| 1983 | 0.77 | 0.16 | 0.11 | 0.02 | 0.47 | 0.00 |
| 1984 | 0.54 | 0.08 | 0.08 | 0.02 | 0.36 | 0.00 |
| 1985 | 0.51 | 0.05 | 0.05 | 0.01 | 0.40 | 0.00 |
| 1986 | 0.54 | 0.10 | 0.05 | 0.01 | 0.39 | 0.00 |
| 1987 | 0.59 | 0.09 | 0.03 | 0.01 | 0.47 | 0.00 |
| 1988 | 0.54 | 0.07 | 0.03 | 0.02 | 0.42 | 0.00 |
| 1989 | 0.60 | 0.11 | 0.03 | 0.02 | 0.45 | 0.00 |
| 1990 | 0.48 | 0.05 | 0.02 | 0.00 | 0.41 | 0.00 |
| 1991 | 0.40 | 0.06 | 0.02 | 0.00 | 0.32 | 0.00 |
| 1992 | 0.19 | 0.04 | 0.01 | 0.00 | 0.14 | 0.00 |
| 1993 | 0.24 | 0.05 | 0.01 | 0.00 | 0.17 | 0.00 |
| 1994 | 0.20 | 0.08 | 0.01 | 0.00 | 0.11 | |
| 1975-1990 | 0.54 | 0.09 | 0.07 | 0.01 | 0.37 | 0.00 |
| 1991-1994 | 0.26 | 0.06 | 0.01 | 0.00 | 0.19 | 0.00 |

Note: Oregon recomputed all freshwater CWT recoveries for this stock in 1999. This caused some significant changes in estimated AEQ ER in some years from those reported in past opinions.

**Table 10. Summary of total adult equivalent exploitation rates for an aggregate of tule stocks from the Lower Columbia River chinook ESU (CTC unpublished).**

| | Tule (Oregon hatcheries, Cowlitz) | | | | | |
|---|---|---|---|---|---|---|
| Brood Year | Total | SEAK | Canada | PFMC | Columbia R. | Other |
| 1971 | | | | | | |
| 1972 | | | | | | |
| 1973 | | | | | | |
| 1974 | | | | | | |
| 1975 | | | | | | |
| 1976 | 0.85 | 0.01 | 0.36 | 0.30 | 0.14 | 0.04 |
| 1977 | 0.77 | 0.03 | 0.29 | 0.35 | 0.09 | 0.01 |
| 1978 | 0.72 | 0.03 | 0.32 | 0.27 | 0.07 | 0.03 |
| 1979 | 0.78 | 0.03 | 0.29 | 0.34 | 0.09 | 0.03 |
| 1980 | 0.70 | 0.02 | 0.38 | 0.16 | 0.09 | 0.05 |
| 1981 | 0.67 | 0.03 | 0.43 | 0.08 | 0.10 | 0.03 |
| 1982 | 0.70 | 0.03 | 0.32 | 0.18 | 0.15 | 0.02 |
| 1983 | 0.75 | 0.02 | 0.24 | 0.23 | 0.23 | 0.03 |
| 1984 | 0.75 | 0.02 | 0.26 | 0.19 | 0.25 | 0.03 |
| 1985 | 0.74 | 0.02 | 0.27 | 0.28 | 0.15 | 0.02 |
| 1986 | 0.57 | 0.03 | 0.18 | 0.27 | 0.06 | 0.03 |
| 1987 | 0.51 | 0.06 | 0.19 | 0.21 | 0.05 | 0.00 |
| 1988 | 0.52 | 0.03 | 0.26 | 0.16 | 0.06 | 0.01 |
| 1989 | 0.67 | 0.03 | 0.20 | 0.37 | 0.06 | 0.01 |
| 1990 | 0.53 | 0.02 | 0.18 | 0.18 | 0.12 | 0.03 |
| 1991 | 0.30 | 0.03 | 0.25 | 0.01 | 0.01 | 0.00 |
| 1992 | 0.28 | 0.02 | 0.04 | 0.14 | 0.07 | 0.01 |
| 1993 | 0.26 | 0.06 | 0.10 | 0.03 | 0.07 | 0.00 |
| 1994 | 0.41 | 0.00 | 0.11 | 0.23 | 0.07 | 0.00 |
| 1976-1990 | 0.68 | 0.03 | 0.27 | 0.23 | 0.11 | 0.02 |
| 1991-1994 | 0.31 | 0.03 | 0.12 | 0.10 | 0.05 | 0.00 |

**Table 11. Summary of total adult equivalent exploitation rates for the North Fork Lewis River bright stock from the Lower Columbia River chinook ESU (CTC unpublished).**

| | Bright (Lewis River) | | | | | |
|---|---|---|---|---|---|---|
| Brood Year | Total | SEAK | Canada | PFMC | Columbia R. | Other |
| 1971 | | | | | | |
| 1972 | | | | | | |
| 1973 | | | | | | |
| 1974 | | | | | | |
| 1975 | | | | | | |
| 1976 | | | | | | |
| 1977 | 0.51 | 0.08 | 0.19 | 0.06 | 0.16 | 0.02 |
| 1978 | 0.56 | 0.15 | 0.14 | 0.09 | 0.18 | 0.01 |
| 1979 | 0.50 | 0.10 | 0.16 | 0.07 | 0.17 | 0.01 |
| 1980 | | | | | | |
| 1981 | | | | | | |
| 1982 | 0.59 | 0.09 | 0.16 | 0.02 | 0.31 | 0.00 |
| 1983 | 0.67 | 0.06 | 0.20 | 0.05 | 0.35 | 0.01 |
| 1984 | 0.45 | 0.03 | 0.15 | 0.03 | 0.24 | 0.00 |
| 1985 | 0.44 | 0.07 | 0.12 | 0.07 | 0.17 | 0.02 |
| 1986 | 0.41 | 0.04 | 0.15 | 0.05 | 0.16 | 0.00 |
| 1987 | 0.38 | 0.05 | 0.13 | 0.05 | 0.14 | 0.01 |
| 1988 | 0.47 | 0.06 | 0.16 | 0.04 | 0.20 | 0.01 |
| 1989 | 0.42 | 0.02 | 0.07 | 0.05 | 0.29 | 0.00 |
| 1990 | 0.45 | 0.07 | 0.10 | 0.01 | 0.27 | 0.00 |
| 1991 | 0.31 | 0.11 | 0.07 | 0.02 | 0.10 | 0.00 |
| 1992 | 0.26 | 0.13 | 0.03 | 0.01 | 0.10 | 0.00 |
| 1993 | 0.41 | 0.14 | 0.05 | 0.00 | 0.22 | 0.00 |
| 1994 | 0.14 | 0.08 | 0.00 | 0.00 | 0.06 | 0.00 |
| 1977-1990 | 0.49 | 0.07 | 0.14 | 0.05 | 0.22 | 0.01 |
| 1991-1994 | 0.28 | 0.12 | 0.04 | 0.01 | 0.12 | 0.00 |

**Table 12. Summary of total adult equivalent exploitation rates for the Nooksack early stock from the Puget Sound chinook ESU (CTC unpublished).**

| | Nooksack Early | | | | | |
|---|---|---|---|---|---|---|
| Brood Year | Total | SEAK | Canada | PFMC | Puget Sound | Other |
| 1971 | | | | | | |
| 1972 | | | | | | |
| 1973 | | | | | | |
| 1974 | | | | | | |
| 1975 | | | | | | |
| 1976 | | | | | | |
| 1977 | | | | | | |
| 1978 | | | | | | |
| 1979 | | | | | | |
| 1980 | | | | | | |
| 1981 | 0.80 | 0.03 | 0.57 | 0.00 | 0.19 | 0.00 |
| 1982 | 0.76 | 0.00 | 0.76 | 0.00 | 0.00 | 0.00 |
| 1983 | | | | | | |
| 1984 | 0.66 | 0.00 | 0.52 | 0.01 | 0.14 | 0.00 |
| 1985 | | | | | | |
| 1986 | 0.86 | 0.00 | 0.18 | 0.00 | 0.68 | 0.00 |
| 1987 | 0.53 | 0.00 | 0.31 | 0.02 | 0.21 | 0.00 |
| 1988 | 0.58 | 0.00 | 0.48 | 0.01 | 0.09 | 0.00 |
| 1989 | 0.55 | 0.02 | 0.40 | 0.02 | 0.11 | 0.00 |
| 1990 | 0.55 | 0.01 | 0.39 | 0.00 | 0.15 | 0.00 |
| 1991 | | | | | | |
| 1992 | 0.39 | 0.00 | 0.28 | 0.00 | 0.10 | 0.00 |
| 1993 | 0.45 | 0.00 | 0.27 | 0.01 | 0.18 | 0.00 |
| 1994 | 0.44 | 0.00 | 0.29 | 0.00 | 0.15 | 0.00 |
| 1977-1990 | 0.61 | 0.01 | 0.35 | 0.01 | 0.25 | 0.00 |
| 1991-1994 | 0.43 | 0.00 | 0.28 | 0.00 | 0.14 | 0.00 |

**Table 13. Summary of total adult equivalent exploitation rates for the Skagit Spring stock from the Puget Sound chinook ESU (CTC unpublished).**

| | Skagit Springs | | | | | |
|---|---|---|---|---|---|---|
| Brood Year | Total | SEAK | Canada | PFMC | Puget Sound | Other |
| 1971 | | | | | | |
| 1972 | | | | | | |
| 1973 | | | | | | |
| 1974 | | | | | | |
| 1975 | | | | | | |
| 1976 | | | | | | |
| 1977 | | | | | | |
| 1978 | | | | | | |
| 1979 | | | | | | |
| 1980 | | | | | | |
| 1981 | 0.73 | 0.03 | 0.51 | 0.00 | 0.19 | 0.00 |
| 1982 | 0.84 | 0.00 | 0.67 | 0.01 | 0.17 | 0.00 |
| 1983 | 0.91 | 0.00 | 0.47 | 0.00 | 0.44 | 0.00 |
| 1984 | 0.78 | 0.01 | 0.34 | 0.00 | 0.43 | 0.00 |
| 1985 | 0.70 | 0.00 | 0.30 | 0.03 | 0.36 | 0.00 |
| 1986 | 0.73 | 0.01 | 0.38 | 0.04 | 0.31 | 0.00 |
| 1987 | 0.71 | 0.00 | 0.26 | 0.06 | 0.39 | 0.00 |
| 1988 | | | | | | |
| 1989 | | | | | | |
| 1990 | 0.57 | 0.01 | 0.37 | 0.02 | 0.18 | 0.00 |
| 1991 | | | | | | |
| 1992 | | | | | | |
| 1993 | 0.50 | 0.00 | 0.23 | 0.00 | 0.27 | 0.00 |
| 1994 | 0.50 | 0.01 | 0.29 | 0.00 | 0.20 | 0.00 |
| 1977-1990 | 0.68 | 0.01 | 0.33 | 0.04 | 0.31 | 0.00 |
| 1991-1994 | 0.50 | 0.01 | 0.26 | 0.00 | 0.24 | 0.00 |

**Table 14. Summary of total adult equivalent exploitation rates for the White Spring stock from the Puget Sound chinook ESU (CTC unpublished).**

| | White River Spring | | | | | |
|---|---|---|---|---|---|---|
| Brood Year | Total | SEAK | Canada | PFMC | Puget Snd | Other |
| 1971 | | | | | | |
| 1972 | | | | | | |
| 1973 | | | | | | |
| 1974 | | | | | | |
| 1975 | | | | | | |
| 1976 | | | | | | |
| 1977 | | | | | | |
| 1978 | | | | | | |
| 1979 | 0.91 | 0.00 | 0.02 | 0.05 | 0.83 | 0.00 |
| 1980 | 0.77 | 0.00 | 0.15 | 0.00 | 0.63 | 0.00 |
| 1981 | 0.51 | 0.00 | 0.00 | 0.00 | 0.51 | 0.00 |
| 1982 | 0.74 | 0.00 | 0.04 | 0.00 | 0.70 | 0.00 |
| 1983 | 0.78 | 0.00 | 0.04 | 0.02 | 0.72 | 0.00 |
| 1984 | 0.71 | 0.00 | 0.14 | 0.03 | 0.54 | 0.00 |
| 1985 | 0.70 | 0.00 | 0.02 | 0.03 | 0.64 | 0.00 |
| 1986 | 0.75 | 0.00 | 0.03 | 0.03 | 0.68 | 0.00 |
| 1987 | 0.68 | 0.00 | 0.03 | 0.03 | 0.61 | 0.00 |
| 1988 | 0.63 | 0.00 | 0.09 | 0.06 | 0.48 | 0.00 |
| 1989 | 0.63 | 0.00 | 0.04 | 0.02 | 0.57 | 0.00 |
| 1990 | 0.74 | 0.00 | 0.04 | 0.00 | 0.70 | 0.00 |
| 1991 | 0.55 | 0.00 | 0.01 | 0.00 | 0.54 | 0.00 |
| 1992 | 0.50 | 0.00 | 0.01 | 0.00 | 0.49 | 0.00 |
| 1993 | 0.46 | 0.00 | 0.01 | 0.00 | 0.46 | 0.00 |
| 1994 | 0.45 | 0.00 | 0.01 | 0.01 | 0.43 | 0.00 |
| 1977-1990 | 0.69 | 0.00 | 0.04 | 0.03 | 0.61 | 0.00 |
| 1991-1993 | 0.49 | 0.00 | 0.01 | 0.00 | 0.48 | 0.00 |

**Table 15. Summary of total adult equivalent exploitation rates for the Stillaguamish summer stock from the Puget Sound chinook ESU (CTC unpublished).**

| | Stillaguamish Fall | | | | | |
|---|---|---|---|---|---|---|
| Brood Year | Total | SEAK | Canada | PFMC | Puget Snd | Other |
| 1971 | | | | | | |
| 1972 | | | | | | |
| 1973 | | | | | | |
| 1974 | | | | | | |
| 1975 | | | | | | |
| 1976 | | | | | | |
| 1977 | | | | | | |
| 1978 | | | | | | |
| 1979 | | | | | | |
| 1980 | | | | | | |
| 1981 | | | | | | |
| 1982 | | | | | | |
| 1983 | | | | | | |
| 1984 | | | | | | |
| 1985 | | | | | | |
| 1986 | 0.65 | 0.00 | 0.31 | 0.05 | 0.28 | 0.00 |
| 1987 | 0.49 | 0.01 | 0.29 | 0.04 | 0.16 | 0.00 |
| 1988 | 0.69 | 0.00 | 0.25 | 0.12 | 0.32 | 0.00 |
| 1989 | 0.88 | 0.00 | 0.44 | 0.10 | 0.34 | 0.00 |
| 1990 | 0.66 | 0.01 | 0.27 | 0.03 | 0.34 | 0.00 |
| 1991 | 0.57 | 0.07 | 0.32 | 0.01 | 0.17 | 0.00 |
| 1992 | 0.41 | 0.01 | 0.27 | 0.01 | 0.12 | 0.00 |
| 1993 | 0.50 | 0.05 | 0.23 | 0.00 | 0.22 | 0.00 |
| 1994 | 0.42 | 0.09 | 0.18 | 0.00 | 0.15 | 0.00 |
| 1977-1990 | 0.67 | 0.00 | 0.31 | 0.07 | 0.29 | 0.00 |
| 1991-1993 | 0.48 | 0.06 | 0.25 | 0.01 | 0.17 | 0.00 |

**Table 16. Summary of total adult equivalent exploitation rates for the Green River fall stock from the Puget Sound chinook ESU (CTC unpublished).**

| Brood Year | Green River fall (Green/Grovers Creek) | | | | | |
|---|---|---|---|---|---|---|
| | Total | SEAK | Canada | PFMC | Puget Sound | Other |
| 1971 | 0.82 | 0.00 | 0.27 | 0.05 | 0.50 | 0.00 |
| 1972 | 0.88 | 0.00 | 0.54 | 0.01 | 0.34 | 0.00 |
| 1973 | 0.82 | 0.00 | 0.38 | 0.04 | 0.39 | 0.00 |
| 1974 | 0.82 | 0.00 | 0.45 | 0.01 | 0.36 | 0.00 |
| 1975 | 0.83 | 0.00 | 0.52 | 0.02 | 0.29 | 0.00 |
| 1976 | | | | | | |
| 1977 | | | | | | |
| 1978 | 0.89 | 0.00 | 0.40 | 0.04 | 0.46 | 0.00 |
| 1979 | 0.89 | 0.00 | 0.37 | 0.02 | 0.49 | 0.01 |
| 1980 | 0.93 | 0.00 | 0.32 | 0.01 | 0.59 | 0.00 |
| 1981 | 0.84 | 0.00 | 0.27 | 0.01 | 0.55 | 0.00 |
| 1982 | 0.72 | 0.00 | 0.36 | 0.02 | 0.34 | 0.00 |
| 1983 | 0.62 | 0.00 | 0.25 | 0.07 | 0.30 | 0.01 |
| 1984 | 0.71 | 0.00 | 0.34 | 0.08 | 0.29 | 0.00 |
| 1985 | 0.62 | 0.00 | 0.25 | 0.10 | 0.27 | 0.00 |
| 1986 | 0.78 | 0.00 | 0.25 | 0.11 | 0.42 | 0.00 |
| 1987 | 0.76 | 0.01 | 0.26 | 0.13 | 0.36 | 0.00 |
| 1988 | 0.82 | 0.00 | 0.28 | 0.11 | 0.43 | 0.00 |
| 1989 | 0.74 | 0.02 | 0.22 | 0.11 | 0.39 | 0.00 |
| 1990 | 0.64 | 0.01 | 0.26 | 0.04 | 0.33 | 0.00 |
| 1991 | 0.53 | 0.00 | 0.18 | 0.01 | 0.34 | 0.00 |
| 1992 | 0.34 | 0.00 | 0.09 | 0.03 | 0.22 | 0.00 |
| 1993 | 0.37 | 0.00 | 0.11 | 0.02 | 0.24 | 0.00 |
| 1994 | 0.49 | 0.01 | 0.14 | 0.02 | 0.32 | 0.00 |
| 1977-1990 | 0.73 | 0.01 | 0.25 | 0.10 | 0.37 | 0.00 |
| 1991-1994 | 0.43 | 0.00 | 0.13 | 0.02 | 0.28 | 0.00 |

**Table 17. Summary of total adult equivalent exploitation rates for the Nisqually fall (Kalama) stock from the Puget Sound chinook ESU (CTC unpublished).**

| | Nisqually fall | | | | | |
|---|---|---|---|---|---|---|
| Brood Year | Total | SEAK | Canada | PFMC | Puget Sound | Other |
| 1971 | | | | | | |
| 1972 | | | | | | |
| 1973 | | | | | | |
| 1974 | | | | | | |
| 1975 | | | | | | |
| 1976 | | | | | | |
| 1977 | | | | | | |
| 1978 | | | | | | |
| 1979 | 0.98 | 0.00 | 0.38 | 0.06 | 0.54 | 0.00 |
| 1980 | 0.99 | 0.00 | 0.39 | 0.00 | 0.61 | 0.00 |
| 1981 | 0.97 | 0.00 | 0.25 | 0.01 | 0.71 | 0.00 |
| 1982 | 0.86 | 0.00 | 0.29 | 0.03 | 0.54 | 0.00 |
| 1983 | 0.92 | 0.00 | 0.31 | 0.01 | 0.59 | 0.00 |
| 1984 | 0.96 | 0.00 | 0.40 | 0.07 | 0.39 | 0.10 |
| 1985 | 0.83 | 0.00 | 0.21 | 0.08 | 0.52 | 0.01 |
| 1986 | 0.91 | 0.00 | 0.25 | 0.13 | 0.53 | 0.00 |
| 1987 | 0.87 | 0.00 | 0.11 | 0.20 | 0.55 | 0.01 |
| 1988 | 0.82 | 0.00 | 0.26 | 0.17 | 0.40 | 0.00 |
| 1989 | 0.84 | 0.00 | 0.24 | 0.11 | 0.49 | 0.00 |
| 1990 | 0.73 | 0.00 | 0.19 | 0.03 | 0.50 | 0.00 |
| 1991 | 0.57 | 0.00 | 0.11 | 0.02 | 0.44 | 0.00 |
| 1992 | 0.73 | 0.00 | 0.10 | 0.02 | 0.61 | 0.00 |
| 1993 | 0.66 | 0.00 | 0.13 | 0.01 | 0.52 | 0.00 |
| 1994 | 0.82 | 0.00 | 0.07 | 0.02 | 0.74 | 0.00 |
| 1977-1990 | 0.83 | 0.00 | 0.21 | 0.12 | 0.50 | 0.00 |
| 1991-1994 | 0.70 | 0.00 | 0.10 | 0.02 | 0.58 | 0.00 |

**Table 18. Summary of total adult equivalent exploitation rates for the Skokomish (George Adams) fall stock from the Puget Sound chinook ESU (CTC unpublished).**

| | Skokomish fall (George Adams) | | | | | |
|---|---|---|---|---|---|---|
| Brood Year | Total | SEAK | Canada | PFMC | Puget Sound | Other |
| 1971 | | | | | | |
| 1972 | | | | | | |
| 1973 | | | | | | |
| 1974 | 0.98 | 0.00 | 0.50 | 0.03 | 0.45 | 0.00 |
| 1975 | 0.98 | 0.00 | 0.29 | 0.07 | 0.62 | 0.00 |
| 1976 | | | | | | |
| 1977 | | | | | | |
| 1978 | 0.82 | 0.00 | 0.24 | 0.03 | 0.51 | 0.04 |
| 1979 | 0.95 | 0.00 | 0.31 | 0.03 | 0.59 | 0.02 |
| 1980 | 0.91 | 0.00 | 0.28 | 0.01 | 0.62 | 0.00 |
| 1981 | 0.85 | 0.00 | 0.25 | 0.02 | 0.58 | 0.00 |
| 1982 | | | | | | |
| 1983 | | | | | | |
| 1984 | | | | | | |
| 1985 | 0.91 | 0.00 | 0.19 | 0.13 | 0.59 | 0.00 |
| 1986 | 0.93 | 0.00 | 0.27 | 0.16 | 0.51 | 0.00 |
| 1987 | 0.87 | 0.01 | 0.27 | 0.13 | 0.46 | 0.00 |
| 1988 | 0.93 | 0.00 | 0.20 | 0.14 | 0.58 | 0.00 |
| 1989 | 0.86 | 0.00 | 0.42 | 0.15 | 0.28 | 0.00 |
| 1990 | 0.69 | 0.00 | 0.19 | 0.12 | 0.38 | 0.00 |
| 1991 | 0.51 | 0.00 | 0.22 | 0.01 | 0.28 | 0.00 |
| 1992 | 0.46 | 0.00 | 0.18 | 0.05 | 0.23 | 0.00 |
| 1993 | 0.48 | 0.02 | 0.17 | 0.04 | 0.25 | 0.00 |
| 1994 | 0.22 | 0.00 | 0.04 | 0.01 | 0.18 | 0.00 |
| 1977-1990 | 0.87 | 0.00 | 0.26 | 0.14 | 0.47 | 0.00 |
| 1991-1994 | 0.42 | 0.01 | 0.15 | 0.03 | 0.24 | 0.00 |

### D. Influence of Artificial Production

Hatcheries have both positive and negative effects. Hatcheries are playing an increasingly important role in conserving natural populations in areas where the habitat can no longer support natural production or where the numbers of returning adults are now so low that intervention is required to reduce the immediate risk of extinction. However, there are also negative consequences associated with hatchery programs, particularly as they were developed and managed in the past. There are genetic interactions associated with the interbreeding of hatchery and wild fish. There are a number of ecological interactions such as predation of wild fish by larger hatchery fish, competition for food and space, and disease transmission. In addition, fisheries that target hatchery fish may over harvest less productive wild populations. Hatchery reform efforts have been ongoing for several years, and state and tribal co-managers have begun to implement mitigation provisions as part of conservation initiatives (PNPTC/WDFW 2000). Hatchery activities in Puget Sound and the Columbia Basin are currently the subject of ongoing section 7 consultation that are designed to address the adverse effects of ongoing hatchery programs.

### E. Natural Factors Causing Variability in Population Abundance

Changes in the abundance of chinook populations are a result of variations in freshwater and marine environments. For example, large scale changes in climatic regimes, such as El Niño, likely affect changes in ocean productivity; much of the Pacific coast was subject to a series of very dry years during the first part of the decade which adversely affected some the stocks. In more recent years, severe flooding has adversely affected some stocks. For example, the anticipated low return of Lewis River bright fall chinook in 1999 and 2000 is attributed, at least in part, to flood events during both 1995 and 1996.

Chinook salmon are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation likely also contributes to significant natural mortality, although the levels of predation are largely unknown. In general, chinook are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebounding of seal and sea lion populations, following their protection under the Marine Mammal Protection Act of 1972, has resulted in substantial mortality for salmonids. In recent years, for example, sea lions have learned to target UWR spring chinook at Willamette Falls and have gone so far as to climb into the fish ladder where they can easily pick-off migrating spring chinook.

A key factor that has substantially affected many west coast salmon stocks has been the general pattern of long-term decline in ocean productivity. The mechanism whereby stocks are affected is not well understood. The pattern of response to these changing ocean conditions has differed between stocks, presumably due to differences in their timing and distribution. It is presumed that ocean survival is driven largely by events between ocean entry and recruitment to a sub-adult life stage. One indicator of early ocean survival can be computed as an index of CWT recoveries at age 2 relative to the number of CWTs released from that brood year. Indices are available for

Upper Willamette River spring chinook, Lewis River fall chinook, and Nooksack Spring chinook and Samish Fall chinook, which are indicators of spring and fall-type stocks from Puget Sound. The patterns differ between stocks, but each shows a highly variable or declining trend in early ocean survival with very low survivals in recent years (Figures 2-5).

Recent evidence suggests that marine survival of salmon species fluctuates in response to 20-30 year long periods of either above or below average survival that is driven by long-term cycles of climatic conditions and ocean productivity (Cramer 1999) . This has been referred to as the Pacific Decadal Oscillation (PDO). It is apparent that ocean conditions and resulting productivity affecting many of northwest salmon populations have been in a low phase of the cycle for some time. Smolt-to-adult return rates provide another measure of survival and the effect of ocean conditions on salmon stocks. The smolt-to-adult survival rates for Puget Sound chinook stocks, for example, dropped sharply beginning with the 1979 broods to less than half of what they were during the 1974-1977 brood years (Cramer 1999). The variation in ocean conditions has been an important contributor to the decline of many stocks. However, the survival and recovery of these species depends on the ability of these species to persist through periods of low ocean survival when stocks may depend on better quality freshwater habitat and lower relative harvest rates.

Although it is not possible to review here the relative importance of each of these factors on each ESU or stocks within the ESUs, it is clear that it is the combined effect of all of the H's that has led to the decline and resulting current status of the species of concern. In this opinion, NMFS focuses on harvest, in the context of the environmental baseline and the current status of the species. Although harvest can be reduce in response to the species depressed status and the reduced productivity that results from the degradations related to other human activities, the recovery of the listed species depends on improving the productivity of the natural populations in the wild. These improvements can only be made by addressing the factors of decline related to all of the H's that will be the subject of future opinions and recovery planning efforts.

**Figure 2. Early ocean survival rate index for Lewis River wild chinook (LCR ESU)**

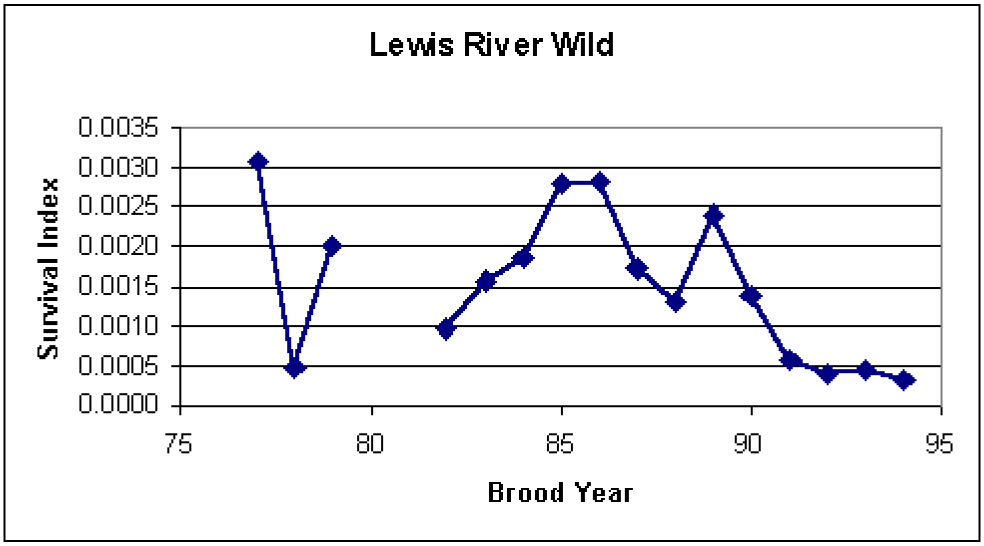



**Figure 3. Early ocean survival rate index for Willamette River spring chinook (UWR ESU).**

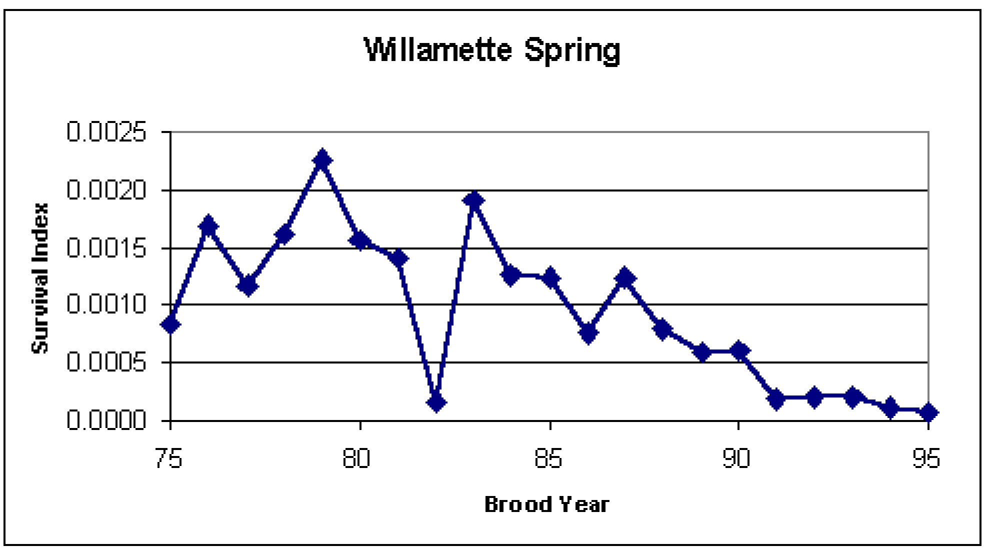


**Figure 4. Early ocean survival rate index for Nooksack early chinook (PS ESU)**

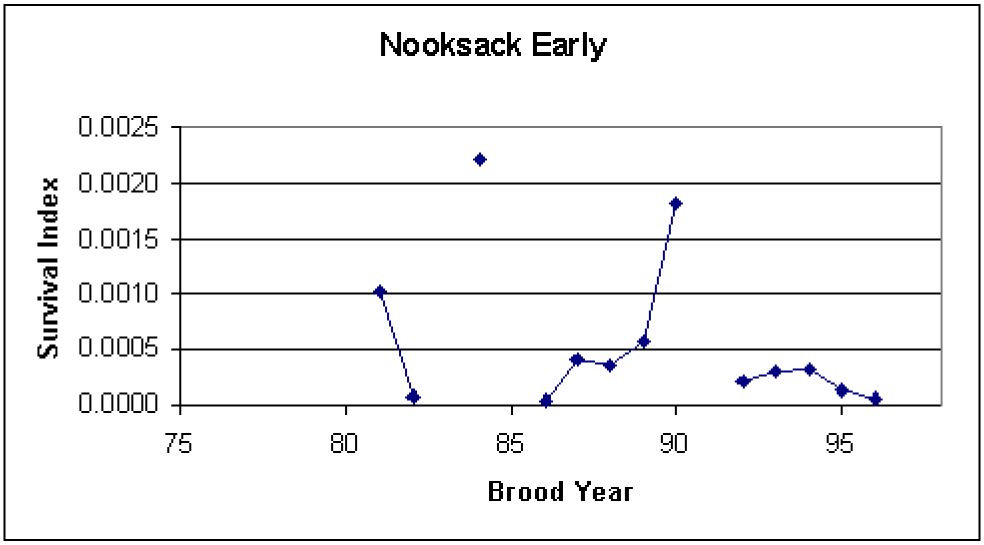
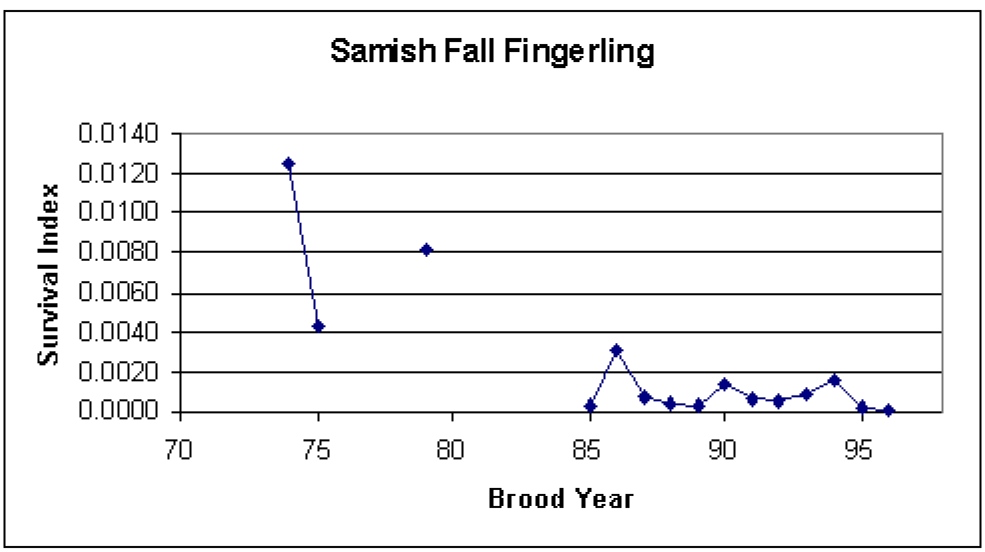



**Figure 5. Early ocean survival rate index for Samish fall chinook (PS ESU)**



## IV. Effects of the Action

The standards for determining jeopardy are set forth in Section 7(a)(2) of the ESA as defined at 50 CFR §402.02. This section of the Biological Opinion applies those standards in determining whether the proposed fisheries are likely to jeopardize the continued existence of one or more of the threatened or endangered salmon species (ESUs) that may be adversely affected by the fisheries, or adversely impact critical habitat. This analysis considers the direct, indirect, interrelated and interdependent effects of the proposed fisheries and compares them against the Environmental Baseline to determine if the proposed fisheries will appreciably reduce the likelihood of survival and recovery of these listed salmon in the wild.

*Assessment Approach*

The jeopardy determinations in this opinion are based on the consideration of the proposed management actions taken to reduce the catch of listed fish, the magnitude of the remaining harvest, particularly in comparison to the period of decline, available risk assessment analyses, and in some cases estimates of target ERs which were derived to be consistent with recovery. NMFS also paid particular attention to the population structure of each ESU by reviewing both the status and impacts to components that were considered representative or important to the ESU as a whole. The jeopardy determinations are based on quantitative assessments where possible and more qualitative considerations where necessary. Different methods and different types of information were used for the various ESUs and populations within ESUs, reflecting what was available or could be developed as part of this consultation. NMFS expects that more quantitative and holistic analyses and risk assessments will become available in time, and that standards may change as new information becomes available. In the meantime, NMFS must rely on the best available information in making its judgement about the risk of the proposed action to the listed species.

In addition to the considerations above, the effect of the proposed actions on the Puget Sound chinook ESU was evaluated as to whether (1) a significant proportion of the remaining genetically unique and indigenous salmon populations (Category 1) were protected, (2) the demographic and genetic risks to populations currently considered to be critical and necessary to the protection of the ESU were not appreciably increased, and; (3) the geographic distribution and life histories of natural populations within the PS chinook ESU were sufficiently protected (Robinson 1999).

The ESUs that were subject to more detailed analyses in this Effects of the Action section included HCS chum, and LCR, UWR, and PS chinook. The analysis for HCS chum relied to a large degree on an analysis that compared observed escapements with those that would have occurred under a proposed management regime that defines the limits of anticipated future harvest for all fisheries.

Analyzing the effects on the other three chinook ESUs that are most affected by the proposed fisheries (UWR, LCR, and PS chinook) required a different approach since there are no existing standards or alternative life cycle analyses for these species.

The method used here was first introduced in the recent PST opinion (NMFS 1999c) and applied in particular to PS chinook. The method is extended and applied to additional stocks in this opinion. It was developed with three objectives in mind. First, NMFS sought to evaluate the proposed fisheries using biologically-based measures of the total exploitation rate that occurred across the full range of the species. Second, NMFS sought to use an approach that was consistent with the concepts developed by the NWFSC for the purpose of defining the conservation status of populations and ESUs, i.e.,Viable Salmonid Populations (VSP) (McElhaney *et al.* 1999). Finally, NMFS sought to develop an approach for defining target ERs that could be related directly to the regulatory definition of jeopardy. The product of this approach is a set of recovery exploitation rates (RER) for representative stocks within each ESU. Recovery ERs were developed for a limited set of stocks from PS and the LCR ESUs. The proposed fisheries were then evaluated, in part, by comparing the RERs to stock-specific ERs that can be anticipated as a result of the proposed 2000 fishery regime, recognizing that the jeopardy determination must be made with respect to the overall ESU. More qualitative considerations were used to extrapolate where necessary from the available stocks-specific RER analyses.

Because RER objectives are expressed in terms of a total exploitation rate and some of the associated impacts occur in Canadian and Alaskan fisheries, it is necessary to make assumptions about anticipated impacts in the northern fisheries. In general, Alaskan fisheries will be managed up to the limits allowed under the PST agreement, but Canadian fisheries will be substantially more restrictive because of domestic conservation concerns for Canadian stocks. Assumptions about fishing levels in these northern fisheries were incorporated into the modeling analysis of impacts (PFMC 2000b,c).

There are four steps involved with determining population specific RERs: 1) identify populations, 2) set critical and viable threshold abundance levels, 3) estimate population productivity as indicated by a spawner-recruit relationship, and 4) identify an appropriate RER through simulation.

Determinations about population structure have not been made for any of the ESUs that are of immediate concern in this opinion. The status discussions in section II.C. describe the existing stock structure for the UWR, LCR, and PS chinook ESUs. The stock structure of the UWR is relatively simple with only three naturally-reproducing stocks. Puget Sound chinook have what may be the most complex structure with nearly 30 identified stocks. The LCR ESU is intermediate in terms of its complexity with three distinct life history types, but with relatively few representative stocks for each. Whether or to what degree these stocks will be aggregated to form populations is not known at this time. However, the intent of the VSP approach is clearly to recognize and protect the diversity of populations that may exist within an ESU and, in assessing the effect of an action, to stratify the ESU adequately to represent the unique population characteristics of the ESU. This should include, for example, unique life history or genetic characteristics, geographic distributions and so on. Although the analysis in this opinion was limited to a degree by available data and time, particularly with respect to PS chinook, the importance of population structure within each ESU provided the focus for the analysis and discussion.

The VSP paper develops the idea of threshold abundance levels as one of several indicators of population status (others being productivity, spatial structure, and diversity). The thresholds described include a critical threshold and a viable population abundance level. The critical threshold generally represents a boundary below which uncertainties about population dynamics increase and therefore extinction risk increases substantially. The viable population threshold is a higher abundance level that would generally indicate recovery or a point beyond which ESA type protections are no longer required with the caveat that abundance is not the only relevant or necessary indicator of recovery.

Determinations regarding threshold abundance levels will logically follow population decisions. As indicated above, the VSP work has not yet provided specific guidance related to population structure for any of the ESUs of concern. Until such guidance is available, the populations considered here are based on information contained in the Salmon and Steelhead Stock Inventory (WDF *et al* 1993). The VSP paper does provide several rules of thumb, that are intended to serve as guidelines, for setting population specific thresholds (McElhaney *et al.* 1999). Unfortunately these guidelines continue to evolve as part of the ongoing development process. However, because the thresholds were needed to set the RERs, NMFS considered the existing rules of thumb, and other relevant guidance, to make preliminary threshold determinations for selected "populations."

The critical threshold was developed from a consideration of genetic, demographic , and spatial risk factors for each population. Genetic risks to small populations include the loss of genetic variation, inbreeding depression, and the accumulation of deleterious mutations. The risk posed to a population by genetic factors is often expressed relative to the effective population size, or the size of an idealized population that would produce the same level of inbreeding or genetic drift that is seen in an observed population. Guidance from the existing VSP paper suggests that effective population sizes of less than 500-5,000 per generation are at increased risk. The population size range per generation was converted to an annual spawner abundance range of 125-1,250 by dividing by four, which is the approximate generation length. As escapement level of 200 fish was selected from this range to represent a critical threshold for genetic risk factors (method 1) since most of the stocks that were subject to the RER analysis were relatively small. For example, the interim escapement objectives for the Nooksack stocks are 2,000 fish each. Threshold values much larger than 200 would be out of context for the stocks of concern.

The Biological Requirements Work Group (BRWG 1994) took genetic considerations and other factors into account in their effort to provide guidance with respect to a lower population threshold for Snake River spring/summer chinook. They recommended annual escapements of 150 and 300, for small and large populations, which represented levels below which survival becomes increasingly uncertain due to various risk factors and a lack of information regarding populations responses at low spawning levels. This provides independent support for the use of

200 (which is within the range of 150-300) as a critical threshold.

Factors associated with demographic risks include environmental variability and depensation. Depensation, or a decline in the productivity of a population (e.g., smolts per spawner) as the abundance declines, can result from the uncertainty of finding a mate in a sparse population and/or increased predation rates at low abundance. Demographic risks were assessed using both the Dennis model (method 2) (Dennis et al. 1991) and a Ricker stock-recruit model (method 3). The Dennis model can be used to provide an estimate of the number of spawners required to have a desired level of probability that the population does not become extinct within a defined period of time. For this analysis, NMFS estimated the population size that would be required to have a 95% probability that the population would not become extinct within 10 years. The final alternative (method 3) for the critical threshold was derived from an analysis of the Ricker stock-recruit relation. Peterman (1977, 1987) provided a rationale for depensation and suggested relating the escapement level at which depensation occurs to the size of the population in the absence of fishing (equilibrium escapement level). NMFS set this measure of the critical threshold equal to 5% of the equilibrium escapement level.

Each of the three measures of the preliminary critical threshold were considered in the context of the types and quality of data available, the characteristics of the watershed, and the biology of the population. For "large populations," NMFS typically selected a critical threshold based on method 3 to assure a sufficient density of spawners. Method 1 was used for 2 small population and two populations for which NMFS was unable to estimate the equilibrium population size.

Similar methods were used to establish the viable population or recovery level. In this case, the criteria were1,250 spawners (genetics; derived from the VSP guideline range of 5,000-16,700 divided by the average generation length of approximately 4 years) or the level of escapement required to achieve the maximum sustainable yield (demographics). Again, the decision of which method to use was based on a consideration of the context of the types and quality of data available, the characteristics of the watershed, and the biology of the population.

The third step in the process of identifying population specific RERs is to estimate the stock-recruit parameters. Estimates of the Ricker stock-recruit parameters for each population were required for both establishing the escapement threshold levels and for the simulations of population dynamics. These parameters were estimated using methods developed by the Chinook Technical Committee and applied on a coast-wide basis (Chinook Technical Committee, in press).

The final step in determining RERs is to use a simulation model to iteratively solve for an exploitation rate that meets specific criteria that are related to both survival and recovery given the specified thresholds and estimated spawner/recruit parameters. The consultation regulations define "jeopardize the continued existence" to mean:

> "... to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in

the wild by reducing appreciably the reproduction, numbers, or distribution of the species" (50 CFR section 402.2).

The simulation then uses a quantified level of risk associated with this definition - "... reduce appreciably the likelihood of survival and recovery ..." - and the population specific threshold levels to identify an ER that meets the following criteria:

1) Did the percentage of escapements less than the critical threshold value increase by less than 5 percentage points relative to the baseline?

and, either

2a) Does the escapement at the end of the 25 year simulation exceed the recovery level at least 80% of the time?

or

2b) Does the percentage of escapements less than the recovery level at the end of the 25 year simulation differ from the baseline by less than 10 percentage points?

For comparison purposes, these simulations were measures against simulations that assumed these species were not harvested anywhere (a zero exploitation rate). In addition, the simulation model uses available information on management error, and errors in measurement of the stock-recruit parameters used in the model to account for uncertainty in management precision and parameter estimation.

The RER is then the level of exploitation rate that results in a low probability that the proposed harvest action will endanger the survival of the population, and a relatively high probability that the proposed harvest action will not impede recovery as defined in this context. Recovery in this context means achieving the viable abundance threshold for a population, assuming current habitat conditions. A separate recovery planning process is currently underway that will ultimately define recovery in terms of necessary improvements in all four Hs and in the context of the ESU as a whole.

Said another way, these criteria seek to identify an ER that will not appreciably increase the number of times a population will fall below the critical threshold and also not appreciably reduce the prospects of achieving recovery. The RER is the highest ER that can meet criterion 1 and criterion 2a or 2b. Once identified, proposed fisheries can be evaluated by considering the likelihood that they will meet the RERs. It is again important to emphasize that the RER analysis is made with respect to populations, while the jeopardy determinations must be made with respect to the anticipated impacts to the ESU. For example, the failure to meet the RER standards for one population in a large ESU does not necessarily indicate jeopardy to the ESU as a whole.

A final step was to convert the RERs based on CWTs into values that could be easily compared with output from models used for domestic harvest management. The Fishery Regulation Assessment Model is used by the co-managers and the PFMC to assess impacts from proposed harvest actions. This step was necessary so that a determination could be made as to whether the exploitation rates from the proposed harvest regimes were consistent with the RERs. This was done by regressing validated FRAM exploitation rates from past years against the brood year CWT-based exploitation rates from which the RERs were derived. The regression relationship was then applied to the RER CWT-based value, resulting in an adjusted RER.

A. Steelhead

Steelhead are caught only rarely in ocean fisheries. Steelhead retention is prohibited in commercial ocean fisheries, but permitted in recreational fisheries. As a result, the recreational sampling programs provide a basis for estimating impacts. On-board sampling of recreational fishing vessels in 1993 and 1994 lead to the conclusion that the ocean recreational fishery off California does not impact sub-legal steelhead (<20" total length) and that the landed catch of steelhead in the recreational fishery averaged ten or less annually (Grover 1995). Grover again confirmed that steelhead are observed only rarely based on observations from on-board monitoring off California (pers. comm. February 12, 1997 with Peter Dygert, NMFS).

The catch of steelhead in recreational fisheries off the Oregon coast are also quite limited. The catch of steelhead since 1978 has ranged from 0 to 281, but since 1988 has averaged only 28 fish per year (Bodenmiller 1995). Recent information regarding the catch of steelhead in Washington ocean recreational fisheries is not available. However, the catch from 1976 - 1987 when catch and effort was substantially higher than it is currently ranged from 0 - 72 while averaging 40 per year (PFMC 1988).

Steelhead are probably also caught on occasion in commercial ocean fisheries. Since retention is prohibited, impacts cannot be assessed directly. However, it is reasonable to assume that encounter rates of steelhead are rare, as suggested by the recreational fishery monitoring programs. Steelhead that are caught and released would presumably be subject to some hooking mortality. The assumed hooking mortality rate in the ocean troll fishery is 26%, which gives an indication of the likely mortality rate to steelhead that may be hooked and released in the commercial troll fishery.

Recent work by Natural Resources Consultants (NRC) confirms that steelhead encounters are rare in the Pacific coast fisheries. NRC conducted encounter rate, hooking mortality, gear selectivity, and creel survey studies off Oregon in 1995-97, in the Buoy 10 fishery at the mouth of the Columbia River in 1995, and in the Strait of Juan de Fuca sport fishery in 1996. During these studies NRC encountered approximately 42,500 chinook salmon, 6,200 coho salmon, 2,100 pink salmon, 2 steelhead and 0 sockeye and chum salmon (pers. comm. G. Ruggerone, NRC to P. Dygert, NMFS, April 10, 1999). This is consistent with the reports mentioned above.

The available information suggests that the total catch of steelhead in the subject fisheries probably averages something on the order of a few 10s but not likely more than 100 fish per year. However, relatively few of these would be listed fish and not all fish caught would be killed. Those caught in the commercial troll fishery would be released, but only a portion, probably on the order of 26%, would die as a result of hooking. Most of the steelhead caught would be unlisted hatchery fish or natural fish from unlisted ESUs. The relative abundance of unlisted steelhead and listed natural fish in the ocean is unknown. However, about 80% of steelhead from the upper Columbia River (above Bonneville Dam) are hatchery origin. The number of listed steelhead that are caught and killed is probably less than 10 fish per year from a total of nine listed steelhead ESUs.

It is unlikely that Puget Sound fisheries significantly affect listed steelhead. Puget Sound steelhead are not listed. The ocean distribution of steelhead is primarily to the north and off shore so few listed steelhead are likely present in Puget Sound. Puget Sound origin steelhead are caught in terminal and freshwater fisheries in Puget Sound, but few steelhead are caught in marine area commercial or recreational fisheries. The recent biological opinion on the PST agreement provides more detail about the ocean distribution and expected impacts to steelhead in Canadian fisheries which are proximate to those in Puget Sound (NMFS 1999c). That opinion concluded that Canadian ocean fisheries are unlikely to encounter more than a few steelhead per year from any of the listed Columbia River ESUs (and none from California ESUs). The catch of listed steelhead from the Columbia River ESUs in southern British Columbia fisheries (Johnstone Strait, Juan de Fuca (Area 20), Nitnat, and Fraser River was estimated to be on the order of 4-10 fish per year. The catch of listed steelhead in Puget Sound fisheries are unlikely to exceed those that occur in Canadian waters.

B. Chum Salmon

1. Hood Canal Summer-Run Chum

NMFS concluded in a previous opinion (NMFS 1999d) that chum were not caught in PFMC fisheries and therefore the HCS chum ESU was unlikely to be adversely affected.

Although a significant proportion of the estimated harvest mortality on the HCS chum ESU occurs outside U.S. waters[7], Hood Canal summer chum are substantially affected by southern U.S. fisheries. From 1974-1998, harvest impacts on the HCS chum ESU ranged from 1% to 57% (0.4% to 10.1% in Washington pre-terminal fisheries and 0.3% to 51.1% in terminal fisheries. The terminal fisheries occurred in Hood Canal and therefore did not affect the SJF component of the ESU.). Southern U.S. exploitation rates averaged 4.7% and 36.3% on the SJF and HC components respectively. Beginning in 1992, fisheries were reduced significantly to protect summer chum and commingled coho and chinook stocks. Since that time, exploitation rates on the SJF and HC components have averaged 0.5% and 1.4%, respectively.(Table 8). The exploitation rate expected under the proposed 2000 fisheries is 4.6% with an upper bound of

[7] These estimates are based on run reconstruction estimates derived from GSI data analysis applied to reported catches.

7.0% on the ESU. The expected exploitation rate on the SJF component is 2.5% with upper bound of 3.5%, and on the HC component of 4.6% with and upper bound of 7.0%. The realized exploitation rate may be even lower if the effort reductions observed in recent years continue.

It is pertinent to consider the potential effects of recent protective fisheries actions and other recovery efforts. Although the exploitation rate across all fisheries has been high in past years, averaging 45% from 1974-1994, it has been reduced to an average of 3.8% since 1994. Canada closed its Area 20 fishery in 1999 (historically, 30% or more of the fishing mortality on the Hood Canal summer chum ESU) and has agreed to release chum from Area 20 fisheries in subsequent years under the new PST agreement. U.S. managers are finalizing negotiations on a domestic management plan that is expected to result in overall average exploitation rates of 10.8% or less for stocks in the Hood Canal region and 8.8% from the Strait of Juan de Fuca.. These rates include all harvest impacts in Canadian and U.S. fisheries. The plan mandates protective regulations, including harvest prohibition, for 90% or more of the run timing of each summer chum stock within the ESU. Under the plan and as a result of the actions agreed to in the PST chum annex, the exploitation rate in southern U.S. fisheries is expected to average 4.6% with an upper bound of 7.0% on the ESU. The extremely low exploitation rates observed in recent years were primarily the result of extremely restrictive actions taken to protect coho and chinook stocks, and would not be expected to continue should these species rebound. However, this plan anticipates these increases and requires that protective measures be taken for summer chum that ensure exploitation rates will remain low. The harvest actions specified in the plan have already been implemented as part of the 2000 fishing regime in Puget Sound. The terms of the plan also require that the effectiveness of, compliance with, and assumptions in the plan be reviewed and updated with new data every five years.

Although this plan has not been formally reviewed or approved by NMFS, the 2000 fisheries proposed by the co-managers are consistent with actions described in the plan. It therefore provides a context to quantify the anticipated harvest mortality on the HCS chum ESU in these fisheries together with the expected harvest mortality in northern fisheries. NMFS assessed the effect of the proposal on the HCS chum ESU in a previous biological opinion (NMFS 1999c). This assessment involved a simple retrospective simulation that compared the escapement resulting from the exploitation rate targets and ranges expected for all fisheries combined under the co-managers' plan, to those observed during 1974-1991 in particular and to a no fishing regime. The escapements through 1991 have been some of the lowest observed and included a wide range of observed survivals. In addition, supplementation programs had not been implemented prior to 1991 so that escapements were not confounded with adults produced from these programs. To provide a more conservative analysis, the simulations compared observed escapements with escapement outcomes at the upper bound of the total exploitation rates for each region of the HCS ESU.

The co-managers plan establishes critical thresholds for Management Units within the HCS chum ESU. Except for the Mainstem Hood Canal Management Unit, all the others are comprised of a single population (PNPT/WDFW 2000). These critical escapement thresholds were based on the lowest abundance observed from 1974-1998 with a positive observed recruitment, plus a buffer of 25% of the difference between the highest and lowest abundances observed. The buffer was added to take into account management and forecast uncertainties, and environmental variation. A critical escapement level was derived by applying the expected exploitation rate under the plan to the critical escapement level. These thresholds were derived prior to the availability of the VSP, but they meet or exceed the VSP guidelines, and are generally conservative when compared to the size of the populations historically (Table 3, Table 19).

The results of the simulation show that trends for populations in both regions are not substantially different than if there had been no fishing, when compared with the abundances observed historically when exploitation rates were much higher. Hood Canal in particular would have benefitted from the reduced exploitation rates (Figure 6). Populations would have been above threshold escapement levels in most years, and dramatically above the observed values. In those years when abundance fell below threshold escapement levels, the results show that fishing would not have been a contributing factor, i.e., the escapement would have fallen below the threshold even if fishing mortality had been 0. Results from the simulation for the SJF indicate that in some years populations would have been depressed even absent all harvest, but that reduced harvest would have allowed for population growth over what was observed in years when the inherent productivity of the system permitted (Figure 7). It is apparent from the model results that the summer chum populations in the SJF region have been constrained by environmental conditions, as opposed to summer chum populations in the Hood Canal region in which reduced fishing might have made a significant difference to annual escapement, and in long-term population growth. Results from both models indicate that survival of populations in the HCS chum ESU is highly variable. In fact, this kind of highly variable survival is characteristic of chum populations in general and summer chum in particular that spawn in the lower end of rivers and are therefore particularly vulnerable to adverse environmental events during the window between spawning and out migration. Hood Canal summer-run chum are also at the southern end of the distribution of summer-run chum which again suggests their greater dependence on high production in years when environmental conditions are favorable.

**Table 19. Critical thresholds (WDFW/PNPT 2000) by Management Unit compared against past average escapements.**

| | | **Critical Thresholds** | | **Escapement Averages** | | |
|---|---|---|---|---|---|---|
| **Region** | **Management Unit** | **Recruit** | **Escapement** | **Early**[8] | **Interim**[9] | **1995-99** |
| Strait of Juan de Fuca | Discovery Bay | 790 | 720 | 1,448 | 293 | 846 |
| | Sequim Bay | 220 | 200 | 475 | 184 | 84 |
| Hood Canal | Mainstem Hood Canal | 2,980 | 2,660 | 15,355 | 1,891 | 3,391 |
| | Quilcene/Dabob Bays | 1,260 | 1,110 | 4,157 | 1,138 | 5,699 |
| | SE Hood Canal | 340 | 300 | 241 | 724 | 421 |
| | HCS ESU | 5,400 | 4,750 | 30,895 | 5,512 | 10,424 |

[8] These include escapements from 1974-78 for the HC region and 1974-88 for the SJF region since the HC stocks declined earlier than those in the SJF region.

[9] These include escapements from 1979-94 for the HC region and 1989-94 for the SJF region since the HC stocks declined earlier than those in the SJF region.

**Figure 6. Comparison of summer chum stock escapements in the Hood Canal region of the HCS chum ESU resulting from various exploitation rates.**

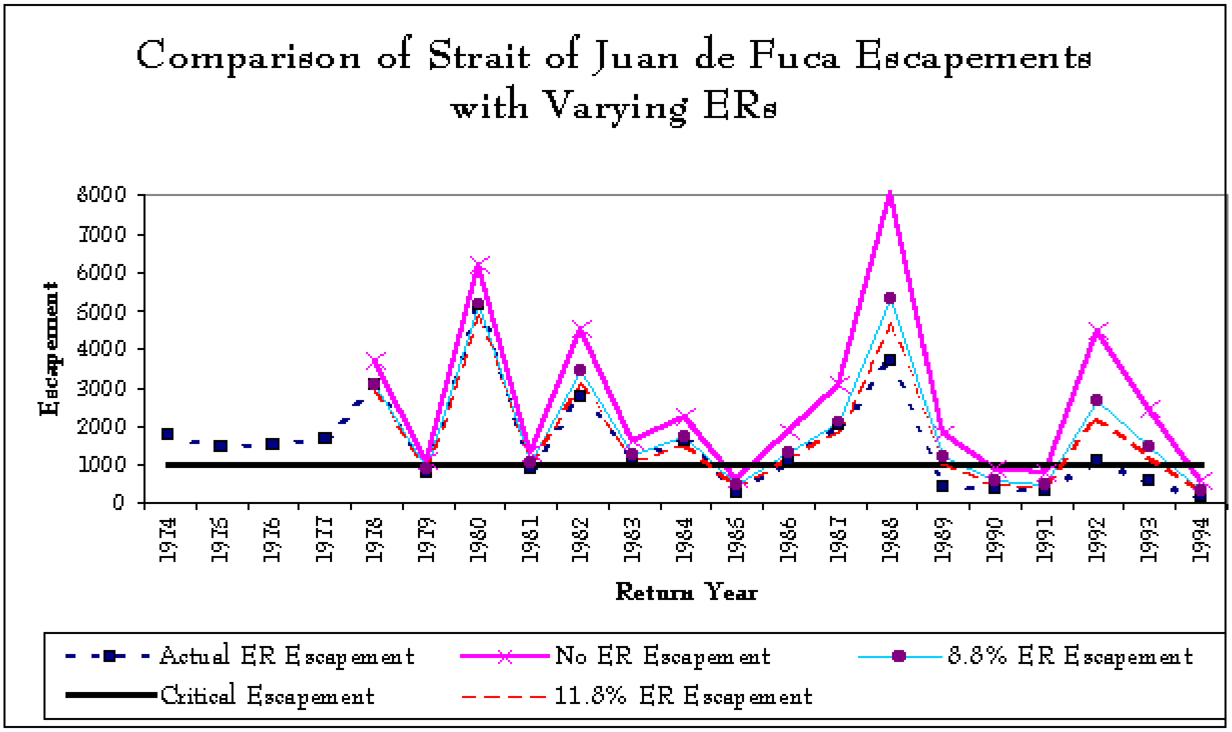
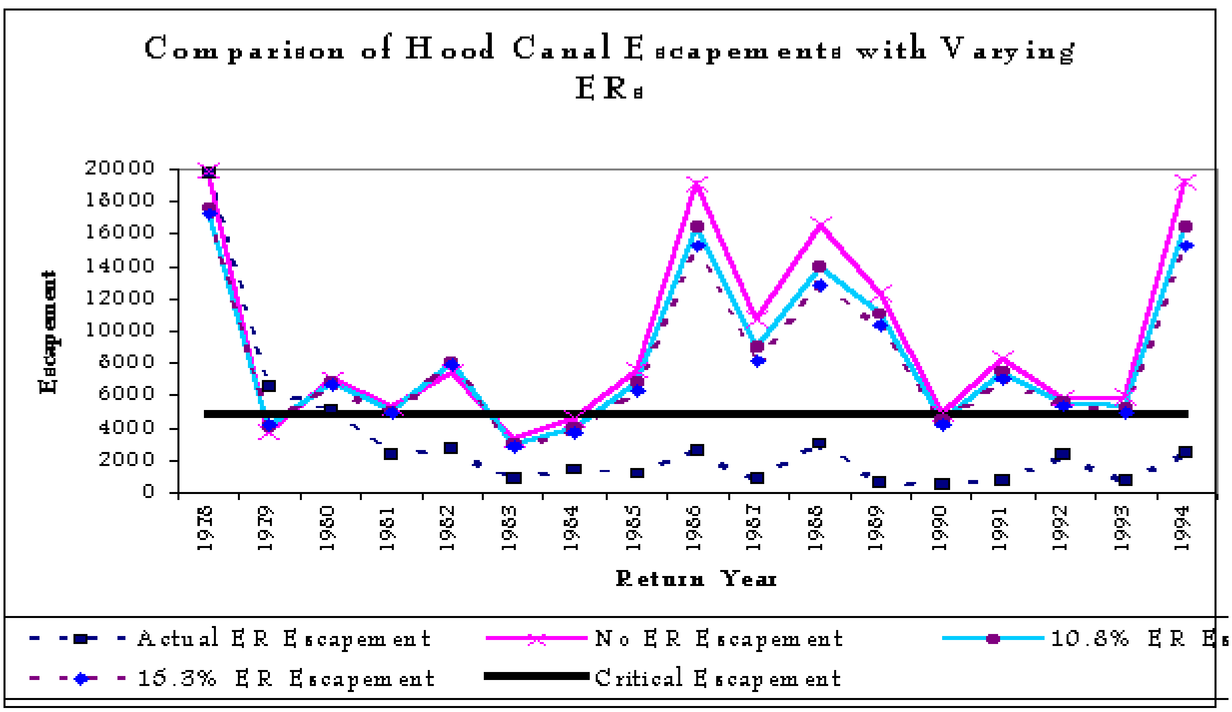



**Figure 7. Comparison of summer chum stock escapements in the Strait of Juan de Fuca region of the HCS chum ESU resulting from various exploitation rates.**



2. Lower Columbia River Chum

Chum salmon in the Columbia River is currently limited to just two areas: Grays River near the mouth of the Columbia River, and Hardy and Hamilton creeks that are just downstream of Bonneville Dam. Small numbers of adult chum salmon have been observed in several other lower Columbia River tributaries. A few chum cross Bonneville Dam in some years, but these are likely lost to the system as there are no known spawning areas above Bonneville Dam. Grays River chum salmon enter the Columbia River from mid-October to mid-November, but apparently do not reach the Grays River until late October to early December. These fish spawn from early November to late December. Fish returning to Hamilton and Hardy Creeks begin to appear in the Columbia River earlier than Grays River fish (late September to late October) and have a more protracted spawn timing (mid-November to mid-January).

PFMC fisheries are closest to the terminal area. However, chum salmon are neither targeted or caught in PFMC fisheries. The available infomation suggests that the overall ocean impact on CR chum is therefore likely quite low.

In Puget Sound fisheries, chum are intercepted incidentally in fisheries targeted at other species and in fisheries targeted on chum. Although no information is available for the presence of Columbia River chum in Puget Sound fisheries, per se, some inferences may be made from the marine distribution of other Columbia River salmonids and the presence of similarly timed fall chum stocks in the Fraser Panel fisheries. There has also been some speculation based on past catch patterns (Henry 1953) that Columbia River chum ocean distribution may be more southerly than other fall chum stocks, similar to the present distribution of Columbia River coho salmon (Sandercock 1991). Puget Sound fisheries accounted for less than 1% of the all the Columbia River coho CWTs recovered between 1979 and 1993 (Weitkamp *et al.* 1995).

Although Puget Sound, Washington Coastal and Columbia River fall chum share similar run timing, the contribution of Washington coastal fall chum is the best surrogate for Columbia River chum since Puget Sound chum are returning to their region of origin and would be expected to be greater contributors to Puget Sound fisheries. The presence of Washington coastal fall chum stocks in the August and early September Canadian Area 20 fishery has been intermittent, comprising 0-8% of the catch sampled in 1995-1997 (LeClair 1999). They have been detected at generally similar levels during October and November in the Washington Commercial Catch Area 5 fall chum fisheries (1985-1996) (Beattie 1999), with no apparent trends in contribution either within or among years. Contribution rates were higher than 9% in 3 of the 62 weeks sampled, but were also not detected in a substantial number of weeks sampled. Using this stock composition estimate would result in an average annual catch of approximately 9 (range 0-21) Columbia River chum in northern Puget Sound fisheries. Given the probable low contribution of these stocks in northern areas, it is unlikely that LCR chum would be encountered in the terminal area fisheries further inside Puget Sound

C. Chinook Salmon

1. Upper Willamette River Chinook

There are three spring chinook stocks in the Willamette River that are still supported to varying degrees by natural origin production. These are found in the McKenzie, North Santiam, and Clackamas Rivers. There has been no determination to date regarding the population structure of the ESU. All of these systems have been substantially influenced by hatchery production and in past years there was substantial exchange of brood stock among the hatcheries with the possible exception of the North Santiam system. The McKenzie River stock is the harvest indicator stock for Willamette spring chinook and, absent other information, it is assumed that the other components have similar distributions and are subject to the same rates of harvest in ocean and pre-terminal fisheries.

Exploitation rates in the other ocean fisheries have been substantially reduced in recent years. The magnitude of that reduction is probably not fully reflected in Table 9 given the very substantial reductions in harvest in Canadian fisheries in the last few years. The effect of this reduction in catch will be more apparent when the 1994 and 1995 brood year estimates become available. The conservative harvest regime that was first implemented in 1994, and particularly 1995, will continue through at least the 2000 season (PFMC 1999c). The total estimated ocean harvest rate in 2000 is projected to be 9% (Table 20) compared to a range of 16-20% observed from 1981-97 .

The model estimate for the ER in 2000 PFMC fisheries is 1.4% (Table 20). PFMC ocean fisheries off the Washington coast do not start until May 1, while the lower river spring stocks enter the river from January through May, with a peak entry timing in late March and early April (ODFW/WDFW 1998). Mature adults migrating through PFMC waters from the north are therefore largely out of the ocean before the fishery begins. The total brood year ER on UWR chinook in PFMC fisheries is estimated to be 1.0% in both the past and near-term time series (Table 9). Estimates of the exploitation rate during the model base period (1979-82) were 0.7% (Scott 1999). This reflects the ocean distribution of the species to the far north. Because of their timing and distribution, UWR chinook will rarely be taken in Puget Sound fisheries. The estimated ER in Puget Sound and other terminal marine areas (Grays Harbor and Willapa Bay) is 0.1% (Table 20).

Until recently UWR chinook were subjected to relatively intense commercial and recreational fisheries in the lower Columbia and Willamette rivers that were directed primarily at the hatchery origin fish. Terminal area ERs have been on the order of 40-50% in past years. Spring stocks from the Upper Columbia, Lower Columbia, Snake, and Willamette rivers are now listed, and as a result, it is safe to assume that ESA constraints, if nothing else, will all but eliminate mixed stock fisheries targeting spring chinook in the Lower Columbia River for the foreseeable future. The harvest rate of UWR spring chinook in the lower Columbia River in 1999 was less than 1%.

Fishery objectives in the Willamette River have also changed to emphasize the protection of natural-origin fish. A revised management plan for the Willamette River spring chinook is being developed by the State of Oregon although it is still subject to review and approval by NMFS. However, Oregon has already implemented a mass marking program and intends to manage terminal area recreational fisheries while requiring the release of all unmarked fish. (Commercial fisheries in the Willamette have long since been disallowed.) The marked fish will fully recruit to the terminal fishery in the year 2002. Once the marked fish are fully recruited to the fishery Oregon expects to manage the lower Willamette River recreational fishery using selective harvest to limit mortality of natural-origin fish to 10% or less until the abundance of natural-origin fish allows for an increase in harvest. The only other potential sources of harvest mortality would be what little may occur in the Upper Willamette recreational fishery or the limited fisheries in the lower Columbia that may target sturgeon for example (Table 9). The North Santiam and Clackamas stocks have also been targeted in terminal area tributary fisheries directed at hatchery-origin stocks, but these too were reduced in 2000 and will be reduced further once the selective fisheries are fully implemented in the terminal areas by no later than 2002.

2. Lower Columbia River Chinook

The LCR chinook ESU is composed of spring run, and fall run tule and bright stocks. There are three spring stocks, three self-sustaining natural-origin tule stocks, and likewise, three identified bright stocks that rely primarily on natural production. The population structure of the ESU has not been determined, but it is intuitively obvious that the spring, tule, and bright life history types warrant independent review with respect to their status and the effect of the proposed action. The effects analysis therefore treats each life history type independently and, where possible, also considers the status of and presumed effect on each stock.

The three remaining spring stocks within the ESU include those on the Cowlitz, Kalama, and Lewis rivers. Although some spring chinook spawn naturally in each of these rivers, the historic habitat for spring chinook is now largely inaccessible. For the time being, the remaining spring stocks depend on the associated hatchery production programs. The hatcheries have met their escapement objectives in recent years thus insuring that what remains of the genetic legacy is preserved. Harvest constraints for other Columbia Basin stocks will provide additional protection for the hatchery programs until such time that a more comprehensive recovery plan is implemented.

These spring stocks have a wider ocean distribution than most stocks originating in the lower Columbia River, and are impacted by ocean fisheries off Alaska, Canada, and the southern U.S. They were also subject, in past years, to significant sport and commercial fisheries inside the Columbia. The chinook management model base period (1979-82) ER for the Cowlitz River spring chinook is 12% for the PFMC fisheries. The 2000 model estimates are for a PFMC ER of 12.5% and a total ocean fishery ER of 15.6% (Table 20). This suggests that LCR spring stocks have a more southerly distribution than the upriver spring stocks which is consistent with the ocean-type juvenile life history that is characteristic of all LCR chinook. Harvest in mainstem fisheries in the LCR will also be low, on the order of 1% or less in recent years, as they have benefitted from the very low harvest rates implemented for the protection of upriver stocks and because they are not subject to tribal ceremonial and subsistence fisheries that occur above Bonneville Dam.

Lower Columbia River spring stocks are not substantially affected by Puget Sound fisheries. Cowlitz River spring chinook are the harvest indicator for LCR spring stocks. The estimated ER on Cowlitz spring chinook in Puget Sound and other terminal marine areas in the 2000 fisheries is 0.2% (Table 20).

The three tule stocks in the ESU include those on the Coweeman, East Fork Lewis, and Clackamas rivers. These are apparently self-sustaining natural populations without substantial influence from hatchery-origin fish. These stocks are all relatively small. The interim escapement goals on the Coweeman and East Fork Lewis are 1,000 and 300, respectively. Escapements have been below these goals 8 of the past 10 years for the Coweeman, and 5 of the past 10 years for the East Fork Lewis. The 10 year average escapement for the Coweeman is 700 , compared to a recent 5 year average of 995 (range 146-2,100). In the East Fork Lewis, the 10 year average escapement is 300, compared to a recent 5 year average of 279. There is currently no escapement goal for the Clackamas where escapements have averaged about 350 per year.

Until recently tule hatchery production has been prioritized to support PFMC and Lower Columbia River fisheries thus providing the potential for very high ERs. The tule stocks are north migrating, but are most vulnerable to catch in fisheries off the Washington coast, in WCVI fisheries, and in the lower river. In recent years, ESA and other unrelated conservation constraints have substantially limited these fisheries, in particular, even though there have been no specific limits set for natural-origin tule stocks. Exploitation rates in the PFMC fisheries averaged 23% through the 1990 brood year, but declined to 10% more recently (Table 10). Model estimates for the 2000 PFMC fisheries are for an ER of 21.7%. Exploitation rates in Canadian fisheries also have been reduced by a similar magnitude in recent years (27% to 12%)(Table 10). Canadian fisheries in 2000 will continue to be substantially constrained again in 2000.

Escapement information from the Coweeman was used to estimate an RER of 0.65 for natural origin tule stocks. Estimates of RERs are sensitive to assumptions about future survival. For Puget Sound stocks the trends from high to low survival over the last twenty years have been significant and substantially affect RER calculations. The survival rates for LCR tules have varied substantially over the years, but are without apparent trend. The estimated RER value for LCR chinook seems high intuitively and merits further review. However, survival rates and abundance have not declined substantially over time, and escapement goals have been met or exceeded under similar levels of exploitation. This indicates the RER criteria appears appropriate for recovery. The expected ER for all fisheries in 2000 for the Coweeman stock is 0.52, well below the RER.

Harvest impacts to LCR tule stocks in Puget Sound and other terminal marine areas are low. The estimated ER for the Columbia River tule stocks in Puget Sound are 0.4% (Table 20).

Three natural-origin bright stocks have also been identified. There is a relatively large and, at least until recently, healthy stock on the North Fork Lewis River. The escapement goal for this system is 5,700. That goal has been met, and often exceeded by a substantial margin, every year since 1980 except for 1999 and likely 2000. Escapement shortfalls this year and in 1999 are at least partly the result of severe flooding during the 1995 and 1996 brood years. However, recent observations suggest that the decline in recent years may also be related to a more pervasive decline in survival rates which would have longer-term implications for the stock (R. Kope, NMFS, pers. comm., April 4, 2000, w/ P. Dygert, NMFS). These recent observations will warrant further review if projected returns continue to fall below the goal. The Sandy and East Fork Lewis stocks are smaller. Escapements to the Sandy have been stable and on the order of 1,000 fish per year for the last 10-12 years. Less is known about the East Fork stock, but it too appears to be stable in abundance.

The brood year ER on bright stocks averaged 49% through 1990 including about 5% in PFMC fisheries. The average ER for the more recent broods was 28% including 1% in PFMC fisheries. The model estimates for the 2000 fisheries are for an ER of 13.0% including 3.5% in PFMC fisheries. The estimated ER of the Lewis river stock in Puget Sound and other terminal marine area fisheries in 2000 is 0.2% (Table 20).

NMFS did not propose harvest constraints for PFMC fisheries for the LCR bright stocks since it does not appear that the low return in 2000 is indicative of a population at risk of extinction. Harvest constraints are warranted, but, at least for now, are more properly developed through the normal management processes. The states of Oregon and Washington have managed the combined southern U.S. ocean and in-river fisheries for an ER of less than 10% in 1999 and 2000 in response to the recent year concerns.

3. Puget Sound Chinook

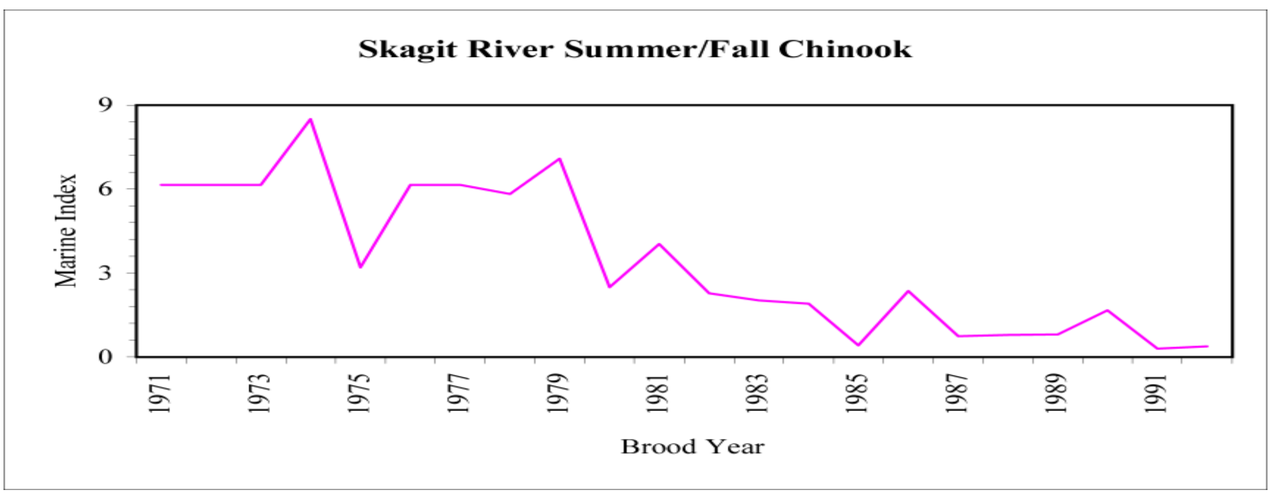
Most of the harvest on Puget Sound stocks occurs in Canadian and Puget Sound fisheries. Exploitation rates in PFMC fisheries on PS chinook are low. In recent years, estimated ERs have been 0-1% for PS spring stocks and 5% or less for PS fall stocks (Tables 12-18).

Once again, the relationship among stocks within the PS ESU and how they might eventually be aggregated into populations has not been determined. The co-managers have identified 28 stocks that are aggregated into 14 management units from five geographic regions (Table 6). The stocks have been categorized into 3 groups with the Category 1 stocks being those that are genetically unique and indigenous to their watersheds. Given the complexity of the Puget Sound ESU and relatively limited time, it was necessary to select a subset of stocks for the more detailed quantitative analyses and then use more qualitative assessments through association about the effects to other stocks. It was logical first to focus the analysis on the indigenous Category 1 stocks, and then among these to also consider both spring and summer/fall type stocks.

Recovery ERs calculated for the eight Category 1 stocks represent four Management Units, including Nooksack, Skagit summer/fall, Stillaguamish, and Green River stocks. It was possible to calculate RERs either for the aggregates or for the individual stocks. The available information suggests that the North and South Fork Nooksack stocks are isolated and unique and therefore warrant separate treatment. Future determinations related to the population structure of the Skagit stocks will be relevant. However, the available information suggest that there are discernable distinctions in genetics and abundance trends among these stocks. There also seem to be differences in relative productivity with the Lower Sauk stock doing poorly and the upper Skagit stock doing relatively well. Since the upper Skagit stock is relatively abundant, it tends to dominate the results of a combined stock analysis leading to RER estimates that may be inappropriate for the weaker components. The same might be said of the Stillaguamish stocks where the more abundant North Fork summer stock dominates the much weaker South Fork fall stock. These stocks may eventually be aggregated in some way to form a larger population and this would affect the conclusions. However, until the population determinations are made, it is more conservative to do the analysis at the finer level of resolution.

There is a second issue pertinent to the calculation of the RERs. The productivity of these stocks has varied substantially over time. The index for marine survival for Skagit summer/fall chinook (smolt-to-age two survival) indicates that survival rates were high during the decade of the 70s, but then declined and have been low over the last decade (Figure 8). Results of the RER analysis depend greatly on assumptions about future marine survival. Although there is discussion in the literature indicating that ocean conditions may be improving, NMFS is not aware of any clear indicators that the survival rates of Puget Sound salmon have improved in recent years. Therefore, the expected ERs resulting from the proposed 2000 fishing regime are compared to RERs calculated assuming survival similar to those observed in more recent years (1983-1992).

**Figure 8. Early ocean survival rate index for Skagit River summer/fall chinook (Puget Sound) by brood year**



For the Nooksack, Skagit and Stillaguamish stocks we can compare the expected ERs from the proposed 2000 fisheries on the corresponding Management Units to the estimated RER for the weakest component stock within the respective Management Unit (Table 21). The differences among the various Skagit summer/fall highlights the differences in the relative productivities of these systems. The Lower Skagit and Lower Sauk stocks are depressed and can sustain less harvest compared to the Upper Skagit summer stock because the systems in which they reside are less productive. The estimated FRAM RERs[10] for the Lower Skagit, Lower Sauk and Upper Skagit stocks are 0.49, 0.51 and 0.60, respectively (Table 22). Although there are inherent differences in the productivity of natural systems, these results emphasize the need for habitat improvements in particular areas and further underscores the point that relatively healthy and productive stocks like the Upper Skagit summers can sustain substantial harvest and still supply thousands of returning spawners per year. The general goal of recovery should be to improve stock productivity to replicate the success that is characterized by the Upper Skagit summer stock. A comparison of the RERs to the ERs expected from the proposed 2000 fisheries indicates that the ER for the Management Unit (0.29) will be well below the RERs for the Lower Sauk and Lower Skagit stocks.

The status of Nooksack early chinook may reasonably be considered "critical" depending on the specific definition. Most of the harvest of Nooksack early chinook occurs in Canadian fisheries, particularly the Georgia Strait sport fishery which is one of Canada's higher priority fisheries and the fishery closest to the Nooksack terminal area. In Puget Sound, Nooksack early chinook are harvested in fisheries throughout the northern and central parts of the Sound. The status of the North Fork Nooksack is somewhat better than that of the South Fork again reflecting relative differences in system productivity. North Fork escapements during the 1997-1999 period increased substantially over the 1988-96 period (ratio= 3.37), including the highest escapements in the data range. South Fork escapements have declined, but may have stabilized in recent years at around the critical threshold of 200 spawners. These may, in part, be responses to the decline in exploitation rates that have occurred on these broods in recent years from 0.61 to 0.43 (Table 12). The FRAM RER is 0.17 for the North Fork and 0.21 for the South Fork (Table 22). Although the higher South Fork RER may seem counter-intuitive, the model indicates the frequency below the critical breakpoint (4.7%) and above the viable threshold (91.7%) is not significantly different than the model estimates from the North Fork (1.6% and 80%). Both are well below past exploitation rates (Figure 9). Nevertheless, the RERs should be re-evaluated as new information becomes available, and the South Fork stock in particular should be closely watched. The projected 2000 ER for the Nooksack early Management Unit is 0.13 (Table 21, well below the FRAM equivalent RERs for both Nooksack early stocks (Table 22).

The Stillaguamish summer/fall chinook stocks have been chronically depressed. A slightly higher proportion of the total harvest occurs in Canada than in Puget Sound. The majority of

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[10]The CWT-based RERs were converted into values that could be easily compared with output from models used for domestic harvest management. The Fishery Regulation Assessment Model (FRAM) is used by the co-managers and the PFMC to assess impacts from proposed harvest actions. This step was necessary so that a determination could be made as to whether the exploitation rates from the proposed harvest regimes were consistent with the CWT-based RERs.

harvest in Puget Sound sport fisheries, and pre-terminal net and troll fisheries. Unlike the Nooksack early stocks which have had escapements of similar magnitude in the past, escapements to the North Fork Stillaguamish stock has always been substantially greater than those of the South Fork (Table 7). The South Fork has generally been near or below what is currently considered its critical escapement threshold. However, escapements of both the North Fork and South Fork stocks have increased in recent years by 54% and 64%, respectively, over the long-term average (Table 7). The increases in escapements may have resulted, in part, from corresponding decreases in exploitation rates (67% to 48%), and as a result of returns from the supplementation program on the North Fork. The FRAM RER for the North Fork Stillaguamish summer stock is 0.32 and 0.24 for the South Fork Stillaguamish fall stock (Table 22). Both are well below past exploitation rates (Figure 10). The projected 2000 FRAM ER for the Stillaguamish Management Unit is 0.15, well below the FRAM equivalent RERs for both Stillaguamish stocks (Table 21). Inseason fisheries will be managed to be consistent with these expectations (Tulalip/WDFW 2000).

Green River chinook are generally considered healthy, meeting or exceeding the 5,800 escapement goal in most years, although the extent and impact of hatchery production is not fully understood. Although a significant proportion of the harvest occurs in Canada, the majority of harvest occurs in Puget Sound. Green River fish are caught in fisheries throughout the Sound, but the majority of it (53.7% in 2000) occurs in the extreme terminal fisheries. The escapement of naturally spawning adults in 2000 is projected to meet its escapement goal of 5,800, and recent years' escapements have exceeded the goal by 37%. The last five years have been the highest consecutive years of escapement in the past 29 years. Escapements may have benefitted from declines in recent brood year exploitation rates from a long-term ER of 0.73 to 0.43 on recent broods. The Green River RER is generally lower than the historic pattern of exploitation rates (Figure 11) except for recent years. Although the projected 2000 ER for the Green River stock is 0.69 (Table 21), above the FRAM RER of 0.62 (Table 22), the projected escapements from the 2000 fisheries are consistent with maintaining the health of the stock. Inseason updates of run size, and management actions related to terminal fisheries in particular, will be managed to achieve the escapement goal of 5,800 (Hage 2000a, b).

**Table 20. Total 2000 FRAM adult equivalent exploitation rates on Columbia River stocks in various fisheries (PFMC 2000b).**

| Stock | SE Alaska (all gear) | Canada (all gear) | PFMC (troll and sport) | Puget Sound | Washington Coastal Net | Columbia River | Total |
|---|---|---|---|---|---|---|---|
| Lower CR Tule /1 | 0.028 | 0.138 | 0.217 | 0.004 | 0.000 | 0.135 | 0.52 |
| Lower CR brights | 0.058 | 0.026 | 0.035 | 0.001 | 0.007 | 0.003 | 0.13 |
| Lower CR Spring | 0.008 | 0.023 | 0.125 | 0.002 | 0.000 | 0.563 | 0.721 |
| Upper Willamette Spring | 0.045 | 0.031 | 0.014 | 0.001 | 0.000 | 0.097 | 0.188 |

/1 PSC model calibration 2004

**Table 21. Total 2000 FRAM adult equivalent exploitation rates on Puget Sound stocks in various fisheries (PFMC 2000b).**

| | Stock | SE Alaska (all gear) | Canada (all gear) | PFMC (troll and sport) | Puget Sound | Washington Coastal Net | Total |
|---|---|---|---|---|---|---|---|
| | Nooksack Early | 0.011 | 0.076 | 0.009 | 0.028 | 0.007 | 0.130 |
| **RER** | Skagit Summer/Fall | 0.008 | 0.157 | 0.008 | 0.087 | 0.026 | 0.286 |
| **Stocks** | Stillaguamish Summer/Fall | 0.001 | 0.055 | 0.009 | 0.073 | 0.010 | 0.149 |
| | Green River | 0.003 | 0.094 | 0.034 | 0.549 | 0.008 | 0.688 |
| **Non** | Dungeness/Elwha | 0.015 | 0.100 | 0.003 | 0.057 | 0.023 | 0.197 |
| **RER** | Skagit Spring | 0.004 | 0.059 | 0.009 | 0.095 | 0.051 | 0.217 |
| **Stocks** | Snohomish Summer/Fall | 0.003 | 0.054 | 0.024 | 0.158 | 0.022 | 0.261 |
| | Lake Washington Summer/Fall | 0.002 | 0.088 | 0.035 | 0.125 | 0.009 | 0.258 |
| | White River Spring | 0.000 | 0.008 | 0.004 | 0.150 | 0.001 | 0.164 |
| | Puyallup Fall | 0.000 | 0.100 | 0.030 | 0.240 | | 0.380 |
| | Nisqually Summer/Fall | 0.007 | 0.065 | 0.021 | 0.629 | 0.016 | 0.737 |
| | Skokomish | 0.000 | 0.158 | 0.026 | 0.271 | 0.021 | 0.475 |

**Table 22. Recovery ERs assuming low survival rates (average rates for Coweeman), expected ERs from 2000 fisheries and the critical and viable escapement thresholds used in the Risk Assessment Procedure.** RERs are expressed as both CWT rates and equivalent rates compatible with the Fisheries Regulation Assessment Model (FRAM) used for domestic harvest management planning.

| ESU | Stock | Recovery Exploitation Rates | | 2000 Projected Exploitation Rates (FRAM) | Critical Escapement Threshold | Viable Escapement Threshold |
|---|---|---|---|---|---|---|
| | | CWT | FRAM | | | |
| Puget Sound | NF Nooksack | 0.24 | 0.17 | 0.13 | 200 | 1,250 |
| | SF Nooksack | 0.30 | 0.21 | 0.13 | 200 | 1,250 |
| | Upper Skagit/S | 0.54 | 0.6 | 0.29 | 967 | 7,454 |
| | Lower Skagit/F | 0.33 | 0.49 | 0.29 | 251 | 2,182 |
| | Lower Sauk/S | 0.36 | 0.51 | 0.29 | 200 | 681 |
| | NF Stillaguamish/S | 0.45 | 0.32 | 0.15 | 300 | 552 |
| | SF Stillaguamish/F | 0.28 | 0.24 | 0.15 | 200 | 300 |
| | Green River S/F | 0.62 | 0.53 | 0.69 | 835 | 5,523 |
| L. Col. River | Coweeman (Tule) | 0.65 | NA | 0.52/1 | 200 | 330 |

/1 PSC model calibration 2004

**Figure 9. Comparison of NF Nooksack early CWT-based RER with past exploitation rates on the Nooksack aggregate, in southern U.S. fisheries and all fisheries combined [/1].**

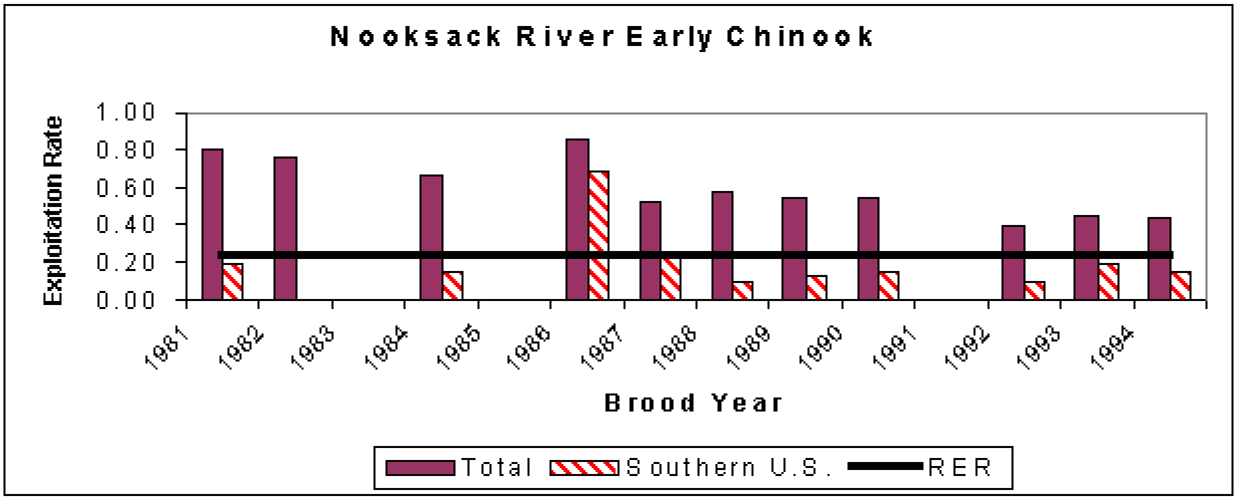



**Figure 10. Comparison of SF Stillaguamish fall CWT-based RER with past exploitation rates on the Stillaguamish aggregate, in southern U.S. fisheries and all fisheries combined [/1].**

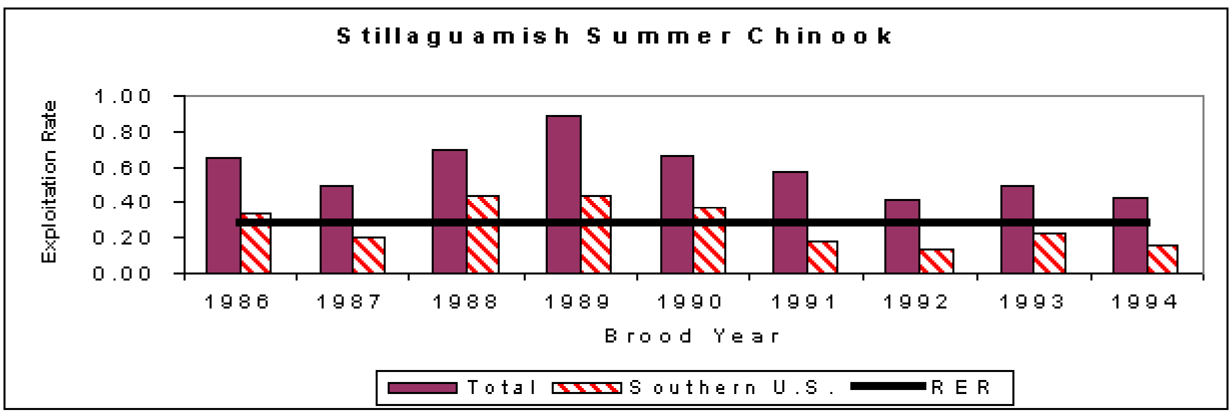
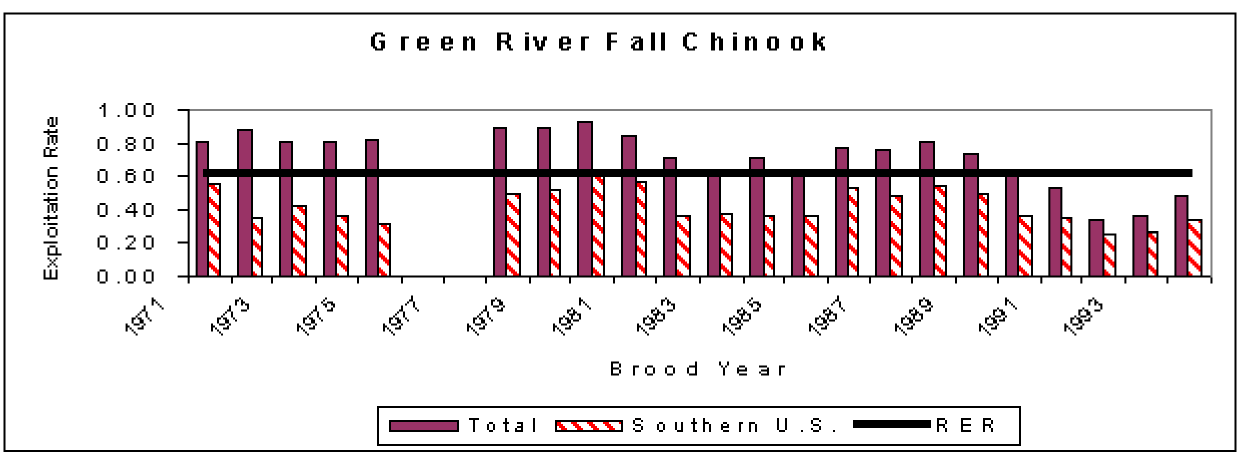



**Figure 11. Comparison of Green River fall CWT-based RER with past exploitation rates in southern U.S. fisheries and all fisheries combined [/1].**




/1 These figures demonstrate past exploitation rates have been relatively high compared to the RERs. If future exploitation rates are consistent with the RERs, harvest will be reduced as a factor of decline.

Estimates of RERs for other stocks are not available at this time. For these stocks, it is therefore necessary to provide a more qualitative assessment of proposed harvest levels. Derivation of the existing RERs suggests that RER estimates are influenced substantially by recent escapement levels and their proximity to the lower critical threshold values. It is therefore reasonable to use currently available RERs as surrogates for stocks of similar abundance and life histories for which RERs are not available.

For spring stocks in Puget Sound, like Nooksack, with escapements close to 200, it is reasonable to expect that RERs will be similar to those estimated for Nooksack. Accordingly, the RERs derived for the Nooksack stocks will be used as surrogates for the White River, Dungeness, and three Skagit spring stocks. These are all classified as Category 1 stocks and are managed for objectives based on natural escapement. FRAM ERs under the proposed 2000 fishing regime for these stocks meet the Nooksack RER standards.

The White River spring chinook stock status is considered critical (WDF *et al.* 1993). Because of its status, a captive brood stock and supplementation program was initiated in the late 1970's. These hatchery intervention programs for the White River spring stock have been successful in rebuilding natural escapements which have increased from less than 30 adults in the early 1980's to 412 (1997-1999). As a result, the captive brood component of the supplementation program for the White River was discontinued. The rebuilding program still relies heavily on the hatchery supplementation program to continue rebuilding the stock. Most of the harvest of White River spring chinook occurs in Puget Sound sport fisheries and freshwater net fisheries. Brood year exploitation rates have declined by 30% in recent years from the long term average (Table 14). The exploitation rate from the proposed 2000 fisheries is estimated as 0.16 (Table 21), below that of both of the Nooksack early stocks (Table 22).

The Dungeness spring stock is also considered critical (WDF *et al* 1993). Dungeness spring chinook escapements have been less than 200 since 1991, and less than 100 in four years of the past seven years. Much of the decline has been attributed to habitat degradation and the effect of limited water flows (Bishop and Morgan 1996). A captive brood stock program began in 1992 to prevent extinction of the stock. The first significant returns from the captive brood stock program are expected back this year, but were not included in the preseason forecast calculations because of uncertainties related to the survival of the returns. The forecast terminal return for the Dungeness is 106 adults. The additional returns are expected from the 1997 release of 1.77 million smolts from the captive brood stock program (Sele 2000). Consequently the modeling was based on conservative assumptions of abundance in 2000. This stock most resembles the South Fork Nooksack in abundance and life history. The harvest is about equally split between Canadian and Puget Sound fisheries. A small amount (2%) is also taken in Alaskan fisheries. The FRAM ER resulting from the proposed 2000 fisheries is estimated to be 0.20, just below the SF Nooksack FRAM RER of 0.21 (Tables 21 and 22). The exploitation rate in all southern U.S. fisheries, as proposed for 2000, is estimated to be 8%. Ultimately, the success of the rebuilding program will depend on significant restoration of chinook salmon habitat in the Dungeness River, and, in fact, there are several restoration efforts under way (Smith and Wampler 1995).

Until the benefits of habitat restoration efforts begin to take effect, the stock will continue to rely on conservative harvest management and rebuilding resulting from the captive brood stock program.

There are three Skagit spring stocks, each of which is similar in abundance and life history to the Nooksack early stocks (Table 7), although recent average escapements are actually somewhat higher for the Skagit spring stocks (Table 7). The three stocks are currently managed as a single Management Unit because they cannot be distinguished until they get the terminal areas. However, escapements have been stable and reasonably well distributed among the three stocks. This suggests the stocks may have similar productivities and that none dominates the system, unlike the Skagit summer/fall stocks. Approximately one third of the harvest impacts occur in Canadian fisheries and the rest occur in Puget Sound fisheries, primarily in the sport and pre-terminal net fisheries. Brood year exploitation rates have declined in recent years from 0.68 to 0.50 (Table 13). The FRAM RER on the Skagit spring chinook Management Unit for the fisheries proposed in 2000 is 0.22 (Table 21), which is comparable to the SF Nooksack FRAM RER of 0.21 (Table 22).

Lake Washington chinook are considered a Category 1 summer/fall stock. Approximately one third of the harvest impacts on Lake Washington chinook are taken in Canadian fisheries. The rest are taken in ocean (3%) and Puget Sound fisheries, with very little taken in any one fishery (Table 21)(PFMC 2000c). Lake Washington chinook are managed for natural escapement, most of which occurs in the Cedar River. Escapements were similar in size to the North Fork Stillaguamish or Lower Sauk summer stocks until 1996 when escapements declined. From 1988-1996 Lake Washington escapements averaged 436. Since that time, escapements have declined, averaging 287, and approaching the generic critical threshold of 200 in some years. The most recent escapements have been more similar to South Fork Stillaguamish and still similar to Lower Sauk summer escapements since that stock has also experienced some decline. Given the decline in recent years and the similarity in life histories, the FRAM RERs for the South Fork Stillaguamish and Lower Sauk summer stocks serve as reasonable surrogates at this time. The FRAM RER for the South Fork Stillaguamish fall and Lower Sauk summer stock are 0.24 and 0.51, respectively. The FRAM ER estimate for the Lake Washington fall Management Unit is 0.26 (Table 21), falling within the surrogate measures. Additional protective measures such as gear restrictions, and required release of live chinook from fisheries targeted at other species in terminal areas (P. Hage (Muckleshoot Tribal Fisheries), K. Rawson (Tulalip Tribal Fisheries) and J. Zischke (Suquamish Tribal Fisheries), pers. comm. to S. Bishop, NMFS, April 14, 2000) will be implemented in 2000 and should provide additional harvest reductions even though the savings were not included in the calculation of the 2000 FRAM ER.

Escapements of fall stocks in the Snohomish, Puyallup, Nisqually and Skokomish River systems are generally higher with close to a thousand or several thousand per year in each. Recovery ERs for these stocks are therefore more likely to be in the range of those estimated for the Skagit summer/fall stocks. Of these stocks, the Snohomish is the only Category 1 stock and has been managed for naturally spawning adults. Beginning in 2000, both the Nisqually and Puyallup summer/fall stocks will be managed for management objectives based on naturally spawning adults. Hatchery strays contribute substantially to natural escapements in all four systems, although the level of contribution varies from system to system. Exploitation rates from the proposed 2000 fisheries for the these stocks range from 0.26 for Snohomish summer/falls to 0.74 for Nisqually summer/fall chinook (Table 21).

The Snohomish Management Unit is comprised of four stocks (Table 6) that vary in stock status from healthy to unknown (WDFW *et al.* 1993). Returns have been fairly stable, falling below 3,000 only twice since 1968. The distribution of spawners has also been relatively even across the four stocks with none that suggest critical stock concerns. Escapements have generally increased since 1997, including 1998, the first time the goal had been met since 1980 (Table 7). The majority of the harvest impacts occur in northern and central Puget Sound fisheries. The FRAM RER on the Snohomish summer/fall chinook Management Unit for the fisheries as proposed in 2000 is 0.26 (Table 21), well below those of the Skagit summer/fall stocks (0.49-0.60) (Table 22). In 1998 and 1999, escapements increased when target preseason ERs were 0.34 and 0.47, respectively. Since the estimated 2000 ER is even lower (0.26), the proposed harvest regime should continue to contribute to the rebuilding of this stock.

The Nisqually, Puyallup and Skokomish summer/fall chinook are Category 2 stocks dominated by hatchery returns. Although still subject to further assessment, Category 2 stocks by definition no longer have an indigenous natural component. All three systems have been managed for hatchery harvest rates for decades. Data collection has begun to try to assess system productivities and to quantify the contribution of hatchery strays to escapements, but it will be several years before sufficient data are available for analysis. The eventual role of hatcheries in these areas will be addressed through recovery planning. The first Section 7 consultation on Puget Sound hatchery programs is currently underway. The harvest and hatchery management strategies are being developed in concert, to provide a consistent approach to resource management in Puget Sound. This year's management begins a period of transition in these areas from a focus on hatchery management to management objectives based on naturally spawning adults. In South Puget Sound, past strategies to maximize harvest of hatchery stocks have resulted in exploitation rates on the Puyallup and Nisqually stocks of 80% to 90%. In 2000, the co-managers began to manage both stocks for naturally spawning escapement objectives.

Nisqually chinook will be managed to achieve a goal of 1,100 naturally spawning chinook. An analysis of the habitat in the Nisqually watershed by the Nisqually Tribe suggested that the equilibrium escapement was approximately 1,200 under current habitat conditions (Nisqually EDT Work Group 1999). The final preseason model projects escapements of naturally spawning adults for the Nisqually of 1,073 and additional management actions will be taken if necessary in the terminal area to ensure the natural escapement objective for the Nisqually objectives is met (PST/WDFW 2000, J. Miniken, Nisqually Tribal Fisheries, pers. comm. to S. Bishop, NMFS, April 14, 2000). Puyallup chinook will be managed to not exceed a total exploitation rate of 0.50. The FRAM ER on the Puyallup stock is estimated as 0.38 (Table 21), well below the objective of 0.50, resulting in a projected escapement of 6,455. These expectations are within the VSP guidelines and consistent with the upper end of the range of escapements observed.

The Skokomish River fall chinook stock is managed for an aggregate escapement of 3,250 and a minimum of 800 naturally spawning adults (PNPT/WDFW 2000). The final preseason estimates are for a natural escapement of approximately 1,008 naturally spawning adults (Lampsakis 2000). The FRAM ER is estimated as 0.48 (Table 21). Escapements of naturally spawning adults have been generally stable and the expected escapement is just above the long-term average (Table 7). Declines in exploitation rates of 50% in recent years (Table 18) do not appear to have resulted in increased escapement of naturally spawning adults. In addition, the proportion of escapement comprised of natural spawning has declined in recent years for total escapements of similar size. Both of these indicate an inherent limitation in productivity. As described previously, habitat in the Skokomish River has been significantly degraded, and improvements in habitat will be required before significant improvement in abundance is likely.

### V. Cumulative Effects

Cumulative effects are defined as the "effects of future state or private activities, not involving federal activities, which are reasonably certain to occur within the action area of the federal action subject to consultation" (50 CFR 402.02). For the purposes of this analysis, the action area includes ocean fishing areas off the coast of Washington and marine and freshwater areas within Puget Sound. The production of salmon and steelhead by state hatchery programs will likely continue at some level and has the potential to add cumulative impacts to listed populations in these areas, through competition and predation. Hatchery salmon production also provides targeted harvest opportunity through increasing salmon abundance above that which would occur naturally, although harvest mortality associated with these fisheries is specifically considered in this opinion. At this time, the extent of cumulative impacts from hatchery salmon production is not known. Further evaluation is warranted but this can best be done as part of an overall assessment of species specific hatchery programs. The impacts of hatchery production from Puget Sound and Columbia River hatchery facilities is currently under review through separate consultations.

## VI. Synthesis and Integration

The jeopardy determinations in this opinion are based on the consideration of the proposed management actions taken to reduce the catch of listed fish, the magnitude of the remaining harvest, particularly in comparison to the period of decline, and target RERs which were derived to be consistent with recovery.

### A. Steelhead

Available information suggests that the catch of steelhead in the PFMC salmon fisheries is probably on the order of a few 10s and is not likely to exceed 100 per year. Because some fish caught would be released alive and most of the fish caught would be unlisted hatchery or wild steelhead, the number of listed steelhead killed from the nine listed ESUs is not likely to exceed 10 fish per year.

Puget Sound steelhead are not listed and, except for terminal marine and freshwater fisheries, relatively few steelhead are caught in Puget Sound. The general distribution of steelhead to the north and offshore suggests that few listed steelhead would be found in Puget Sound. NMFS reviewed available information from the contiguous Canadian fisheries of northern Puget Sound and estimated an annual catch of listed steelhead ranging from 4-10 fish per year. The catch of steelhead in Puget Sound fisheries is unlikely to exceed that which occurs in Canadian waters. Given the scope of the proposed actions considered in this opinion and the low level of impact, NMFS has determined that the proposed PFMC and Puget Sound fisheries are not likely to jeopardize the continued existence of any of the listed steelhead ESUs and are not likely to destroy or adversely modify designated critical habitat.

B. Chum

The available information indicates that HCS chum are not caught in PFMC fisheries. HCS chum are caught in Puget Sound fisheries, and past exploitation rates in these fisheries have been inappropriately high. Total fishery exploitation rates on the HCS chum ESU averaged 44.5% from 1974-1994 (range = 12.2%-81.2%) but dropped dramatically in 1995, averaging 3.8% (range = 2.7-5.1%), as a result of fishery actions taken to protect summer chum and other salmonid species. Exploitation rates in PFMC and Puget Sound fisheries are expected to remain low (range= 4.6%-7.0%) under the proposed plan. The expected total exploitation rates is 10.8% with an upper bound of 15.3%. Therefore, NMFS does not believe that the Puget Sound fisheries pose a significant risk to HCS chum and are not likely to destroy or adversely modify designated critical habitat.

The available information suggests that CR chum are rarely, if ever, caught in PFMC or Puget Sound fisheries and that the proposed actions are therefore, not likely to jeopardize the continued existence of CR chum.

C. Chinook Salmon

1. Upper Willamette River Chinook

The available information indicates that UWR chinook are not significantly affected by PFMC or Puget Sound fisheries. The timing and northerly distribution of UWR chinook minimize their vulnerability to the proposed fisheries. The estimated ER in PFMC fisheries averaged 1% over the last 20 brood years. The model estimate for the 2000 PFMC fisheries is 1.4%. Exploitation rates in Puget Sound fisheries are estimated to be 0.1%. Harvest mortality in both ocean and freshwater fisheries will be lower in 2000 than they have been in past years with expected total ocean ERs of about 9% and reductions in freshwater harvest mortality of 50% or more relative to years prior to 1997. Implementation of mass marking and selective fisheries are expected to lead to even further reductions in freshwater harvest mortality in the future. Whether these changes in harvest management policy, coupled with improvements in other sectors, are sufficient to provide for long-term recovery has not been fully analyzed. However, based on the substantial reductions in harvest mortality anticipated in ocean and freshwater fisheries and the fact that harvest mortality in the combined PFMC and Puget Sound fisheries is estimated to be 1.5% or less, NMFS concludes that the proposed fisheries considered in this opinion are not likely to jeopardize the continued existence of UWR chinook and are not likely to destroy or adversely modify designated critical habitat.

2. Lower Columbia River Chinook

What remains of the spring component of the LCR chinook ESU is now confined to the Sandy, Cowlitz, Lewis, and Kalama rivers. There are no natural-origin, self-sustaining populations of LCR spring chinook as all are integrated with and largely dependent on the associated hatchery programs in each basin. Although some natural spawning occurs, most is likely the result of hatchery straying, and it is unlikely that any of the populations would persist given the current habitat conditions absent the existing hatchery programs. The population in the Sandy above Marmot Dam is increasing. Those in the Cowlitz, Lewis, and Kalama are declining, but still number several hundred to a few thousand fish each. Reductions in fisheries to the north will likely benefit LCR spring chinook, and there is very little harvest in the mainstem river fisheries. The estimated ER on Cowlitz spring chinook in 2000 PFMC fisheries is 12.5% and 15.6% in the combined ocean fisheries. The combined ER in 2000 Puget Sound and other terminal marine areas is estimated to be 0.2%. The status of spring stocks on the Washington side warrant close scrutiny in future years and may require more direct protections if declining trends are not reversed.

Lower Columbia River tule stocks have been subject to habitat degradation due to the familiar litany of factors related to resource exploitation and land use development. Hatchery programs have been pervasive throughout the LCR, in particular, for over a hundred year. As a result, there are likely only two or three self-sustaining populations of tule chinook in the lower Columbia River that are not substantially influenced by hatchery strays. Although the status of the Clackamas population is uncertain, escapements to the Coweeman and East Fork Lewis rivers at least are stable and near interim goals.

There is no shortage of hatchery fish including many that are part of the ESU (although not listed) that can be used for recovery efforts. Harvest mortality on tule stocks has been reduced substantially in recent years. Given the circumstances, it seems unlikely that the anticipated harvest in PFMC or Puget Sound fisheries pose a significant risk to the tule component. In this case, the broader objective of the ESA, which requires survival and recovery of self-sustaining, naturally spawning populations, can best be achieved through focused recovery planning efforts that identify habitats that can be rehabilitated, coupled with harvest management programs that provide the necessary protections that will allow for rebuilding. Until then harvest of tule stocks needs to be sufficiently constrained to protect the few remaining naturally spawning populations.

The fact that these populations have been stable in recent years and that overall harvest mortality has declined in recent years suggests that the 2000 PFMC and Puget Sound fisheries do not pose a substantial risk to those populations nor limit the potential for longer-term recovery efforts.

The estimated RER for the Coweeman stock is 0.65. It is not possible to provide a final estimate of the ER for all of the combined 2000 fisheries until preseason planning for the lower river fisheries is completed, however, the expected ER for all fisheries for the Coweeman stock is not likely to exceed 0.52 in 2000. The ER in the proposed PFMC and Puget Sound fisheries is estimated to be 0.221.

The LCR bright component is one of the few healthy wild stocks in the Columbia River Basin. The Lewis River bright stock has exceeded its escapement goal of 5,700 by a substantial margin every year since at least 1980. The low forecast for 2000 has been attributed to severe flooding in 1995 and 1996 that substantially diminished production from the 1994 and 1995 brood years that are the primary contributors to the returns in 1999 and 2000, although there is recent evidence that there may be additional and more pervasive problems with stock survival. However, given the relative health of this stock, and actions taken by managers to hold the combined ER in PFMC and in-river fisheries to 10% or less (3.5% in PFMC), NMFS does not believe that PFMC fisheries pose a substantial risk to the LCR bright populations. Additional harvest impacts in Puget Sound and other terminal marine areas are quite low (ER = 1.1%) and are not considered significant in this context.

As described in section II.C.2 and IV.D.3, the LCR chinook ESU is a complex ESU comprised of several distinct life history types including spring, tule and bright fall-timed stocks. NMFS considered status and stock structure of each life history component of the ESU and impacts from the proposed fisheries on each. Based on the above considerations, NMFS concludes that the proposed PFMC and Puget Sound fisheries are not likely to jeopardize the continued existence of LCR chinook ESU in total and are not likely to destroy or adversely modify designated critical habitat.

3. Puget Sound Chinook

In the Effects section, NMFS considered expected ERs for individual stocks relative to RER values where possible and other qualitative and quantitative considerations of appropriate ERs or escapement objectives where necessary. In looking at the aggregate of stocks that comprise the ESU, NMFS also considered whether (1) a significant proportion of the remaining genetically unique and indigenous salmon populations (Category 1) were protected, (2) the demographic and genetic risks to populations currently considered to be critical and necessary to the protection of the ESU were appreciably reduced, and; (3) the geographic distribution and life histories of natural populations within the PS chinook ESU were sufficiently protected (Robinson 1999).

Exploitation rates on PS chinook have declined significantly in recent years (Tables 12-18). ERs resulting from the proposed 2000 regime are projected to be an average of 30% below recent years' preseason levels. Impacts to individual stocks vary within the Puget Sound ESU (Table 21). Harvest impacts resulting from the proposed fisheries will meet or exceed evaluation criteria set by NMFS for all nineteen of the Category 1 chinook stocks in the PS chinook ESU.

RERs were achieved for all the stocks for which they have been developed (North Fork Nooksack early, South Fork Nooksack early, Upper Skagit summers, Lower Skagit falls, Lower Sauk summers, North Fork Stillaguamish summers, South Fork Stillaguamish falls, Green River) except for the Green River. However, Green River is projected to meet or exceed its natural spawning escapement goal in 2000 under the proposed fisheries. The fact that escapements in the last five years have been well above this goal supports the expectation that the goal will again be met. For the stocks for which RERs were not available, the assumption was made that RERs would be similar for stocks of similar size and life history. For the White River, Dungeness and three Skagit spring stocks the FRAM RERs for the Nooksack early stocks were used as surrogates (0.17-0.21). Like the Nooksack earlies, these stocks express a spring or early-timed life history. Estimated ERs for the White River, Dungeness and Skagit River spring stocks under the proposed 2000 fisheries were consistent with the Nooksack early FRAM RERs (0.16-0.22)(Table 22).

The Lake Washington stocks was most similar to the South Fork Stillaguamish fall and Lower Sauk summer stocks in recent years because of recent abundance levels. The expected FRAM ER for the Lake Washington stocks under the proposed 2000 fisheries is 0.26 (Table 21), falling within the range of surrogate FRAM RERs (0.24 and 0.51)(Table 22).

The four Snohomish summer/fall stocks are more similar in abundance and life history to the Skagit summer/fall stocks. Snohomish escapements have increased in recent years under exploitation rates higher than the Skagit RERs (although they have been lower than historic levels). Under the proposed 2000 fisheries, exploitation rates on the Snohomish stocks (0.26) are projected to be well below the Skagit summer/fall FRAM RERs (0.32-0.60).

Stocks that have been classified as critical (WDF *et al.* 1993) include SF Stillaguamish falls and most of the stocks in the 'smaller stock' category described in the previous paragraph. These include those for which both the natural and hatchery populations have been listed (Elwha, Dungeness spring, NF Nooksack early, SF Nooksack early, White River springs). Although a final determination will come as a result of the recovery planning process, all of the spring stocks may reasonably be considered necessary to the ESU given there are few of the them remaining from what existed historically in the ESU. Exploitation rates on these stocks under the proposed 2000 fishing regime meet RERs or surrogate RERs derived to be consistent with survival and recovery.

The proposed 2000 fishing regime has also been found to be protective of the geographic distribution and life histories of natural populations within the PS ESU. The northern and central areas of Puget Sound are well represented by the stocks described in the preceding paragraphs (Dungeness spring, North and South Fork Nooksack early stocks, Skagit summer, fall and spring stocks, North and South Fork Stillaguamish summer and fall stocks and Snohomish summer/fall stocks). With the exception of White River spring chinook, the South Puget Sound and Hood Canal regions are Category 2 stocks which by definition no longer have an indigenous component. This year's management began a transition from hatchery-based management to management objectives based on naturally spawning adults.

South Puget Sound is represented by White River springs, and Nisqually and Puyallup summer/fall chinook. The White River spring stock is projected to meet its surrogate FRAM RER. Both the Nisqually and Puyallup River summer/fall stocks are projected to meet or exceed their escapement objectives for naturally spawning adults. The Skokomish River has historically been the largest chinook producer in Hood Canal. Exploitation rates have declined by 50% in recent years and escapements have been stable at just above the long-term average. Under the proposed 2000 regime, escapement of naturally spawning adults is expected to be 1,008, close to the lower boundary of the VSP viable abundance demographic guideline of 1,250, and at the middle to upper end of the historic escapement range for the system.

## VII. Conclusion

After reviewing the current status of the listed steelhead, sockeye, chum and chinook salmon ESUs considered in the opinion, the environmental baseline for the action area, the effects of the proposed fisheries, and the cumulative effects, it is NMFS' biological opinion that the proposed PFMC fisheries are not likely to jeopardize the continued existence of any of the nine listed steelhead ESUs, HCS or CR chum salmon or UWR, LCR or PS chinook salmon. The proposed fisheries are also not likely to destroy or adversely modify designated critical habitat. The Puget Sound fisheries include the NMFS Fraser Panel, BIA and USFWS actions. NMFS concludes that these three actions are not likely to jeopardize the continued existence of the HCS chum salmon or UWR, LCR or PS chinook salmon ESUs and are not likely to destroy or adversely modify designated critical habitat.

## INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by NMFS, the BIA and the USFWS. These agencies have a continuing duty to regulate the activity covered by this incidental take statement in consultation with the affected states and tribes. If these agencies fail to assume and implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of take, NMFS must document the progress of the action and its impact on the species as specified in the incidental take statement. [50CFR §402.14(i)(3)]

## I. Amount or Extent of Incidental Take

### A. Steelhead

Steelhead are caught rarely in PFMC ocean salmon fisheries. Some of the steelhead caught may be from ESUs that are not listed. Others may be unlisted hatchery-origin fish. Potential impacts are limited further by non-retention requirements in commercial fisheries. Steelhead proposed for listing may be taken on occasion in PFMC and Puget Sound fisheries, but the available information suggests that the number of listed fish that are caught and killed is likely less than 10 per year in PFMC fisheries or less than1-10 fish per year in Puget Sound fisheries from the combined nine listed steelhead ESUs.

### B. Chum

The available information suggests that chum are not taken in PFMC fisheries. The proposed 2000 Puget Sound fisheries are expected to result in a catch of approximately 9 CR chum (range= 0-21), and an exploitation rate on HCS chum of 4.6%-7.0%.

### C. Chinook Salmon

#### 1. Upper Willamette River Spring Chinook

The available information indicates that UWR chinook are not significantly affected by PFMC or Puget Sound fisheries. The long term average estimated ER in PFMC fisheries is on the order of 1%. The model estimate for the 2000 PFMC and Puget Sound fisheries combined is 1.5%.

#### 2. Lower Columbia River Chinook

The spring component of the LCR chinook ESU differ from upper Columbia River spring stocks in that they have a more southerly distribution and are subject to somewhat higher harvest rates in PFMC fisheries. The chinook management model base period (1979-82) ER for the Cowlitz River spring chinook is 12% for the PFMC fisheries. The 2000 model estimates are for a PFMC ER of 12.7%

The LCR tule stocks are subject to significant harvest in PFMC fisheries. Exploitation rates averaged 23% through the 1990 brood year, but declined to 9% more recently. Harvest impacts to LCR tule stocks in Puget Sound and other terminal area fisheries are low. The model estimate for the ER in 2000 PFMC and Puget Sound fisheries combined is 18.8%.

The ER on LCR bright stocks in PFMC fisheries have averaged 5% in past years. They are not substantially affected by Puget Sound. The model estimate for the ER in 2000 PFMC and Puget Sound fisheries combined is 4.3%.

3. Puget Sound Chinook

Estimated impacts from the 2000 PFMC and Puget Sound fisheries vary by stock, consistent with stock-specific management objectives (Table 21). In some cases the expected take is defined in terms of an exploitation rate and in other cases it is the take that will occur as a result of managing for an escapement objective. The expected takes and escapements are summarized in Table 23, below.

**Table 23. Summary table of estimated exploitation rates or expected escapement by PS stock aggregate (PFMC 2000c).**

| Stock | Exploitation Rate | Escapement |
|---|---|---|
| Dungeness spring | 0.20 | |
| Elwha fall | 0.20 | |
| Nooksack early | 0.13 | |
| Skagit springs | 0.22 | |
| Skagit summer falls | 0.29 | |
| Stillaguamish summer/fall | 0.15 | |
| Snohomish summer/fall | 0.26 | |
| Lake Washington summer/fall | 0.26 | |
| Green River summer/fall | | 5,800[/1] |
| Nisqually summer/fall | | 1,073[/2] |
| Puyallup summer/fall | | 6,445[/3] |
| Skokomish summer fall | | 1,008[/3] |

/1 This stock will be managed inseason to meet or exceed an escapement goal for naturally spawning adults of 5,800.

/2 This stock will be managed inseason to meet or exceed an escapement goal for naturally spawning adults of 1,100.

/3 Assessment of fishing effects on these stocks were based on achieving acceptable levels of escapement.

## II. Effect of the Take

In the accompanying biological opinion, NMFS determined that the level of anticipated take of nine steelhead ESUs, HCS and CR chum, and the UWR, LCR, and PS chinook ESUs in the proposed PFMC and Puget Sound fisheries is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

## III. Reasonable and Prudent Measures

There are two reasonable and prudent measures included in this incidental take statement for the ESUs considered in this opinion. These were also included in the March 8, 1996, biological opinion and remain in effect: 1) in-season management actions taken during the course of the fisheries shall be consistent with the harvest objectives established preseason that were subject to review for consistency in this biological opinion, and 2) harvest impacts of listed salmon stocks shall be monitored using best available measures. To clarify the first measure, NMFS expects that in-season management actions may be taken (Hage 2000a,b; J. Miniken, Nisqually, pers. comm. to S. Bishop, NMFS, April19, Tulalip 2000, WDFW/Tribes 2000, WDFW 2000). However, NMFS analyzed impacts to listed fish resulting from a particular set of harvest objectives and concluded they were not likely to jeopardize the listed species. Therefore in-season actions may be taken so long as they do not result in changing harvest objectives or associated impacts to listed species.

## IV. Terms and Conditions

In order to be exempt from the prohibitions of sections 9 and 4(d) of the ESA, the NMFS, BIA and USFWS must continue to comply with all of the terms and conditions listed in the March 8, 1996, biological opinion, as amended by the February 18, 1997, opinion concerning Sacramento River winter chinook. In addition, the NMFS, BIA and USFWS must comply with the following terms and conditions to implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1. The NMFS, BIA and USFWS shall confer with the affected states and tribes, and the PFMC chair to ensure that in-season management actions taken during the course of the fisheries are consistent with the harvest objectives established preseason.

2. The NMFS, BIA and USFWS, in cooperation with the affected states and tribes, and PFMC chair, shall monitor the catch and implementation of other management measures at levels that are comparable to those used in recent years. The monitoring is to ensure full implementation of, and compliance with, management actions specified to control the various fisheries within the scope of the action.

3. The NMFS, BIA and USFWS, in cooperation with the affected states and tribes, and PFMC chair, shall sample the fisheries for stock composition including the collection of

CWTs in all fisheries and other biological information to allow for a thorough post-season analysis of fishery impacts on listed species.

## CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS believes the following conservation recommendations, in addition to those included in the March 8, 1996, biological opinion, are consistent with these obligations, and therefore should be implemented by the NMFS, the BIA and USFWS.

1. The NMFS, BIA and USFWS in collaboration with the affected states and tribes should evaluate the ability of each listed ESU to survive and recover, given the totality of impacts affecting each ESU during all phases of the salmonid's life cycle, including freshwater, estuarine and ocean life stages. For this effort, NMFS, the BIA and USFWS should collaborate with the affected co-managers to evaluate available life cycle models or initiate the development of life cycle models where needed.

2. The NMFS, BIA and USFWS in collaboration with the affected states and tribes should evaluate where possible improvement in gear technologies and fishing techniques that reduces mortality of listed species.

2. NMFS, BIA and USFWS in collaboration with the affected states and tribes should gather better information on ocean rearing and migration patterns to improve its understanding of the utilization and importance of these areas to listed ESUs.

## REINITIATION OF CONSULTATION

This concludes formal consultation on 2000 fisheries prosecuted pursuant to the Pacific Salmon Plan and the Puget Sound Salmon Management Plan. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of take is exceeded, must immediately reinitiate formal section 7 consultation on the proposed fisheries.

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